CONSTRUCTION AND REPAIR WORK FOR THE FARM

By F. THEODORE STRUCK

EVERY one who has lived in the country knows the importance of the efficient construction of farm buildings and the amount of time, labor, and money that is necessary for their proper upkeep.

This book, by a practical farmer who is now Assistant Director of Vocational Education in the Pennsylvania Department of Public Instruction, gives just the necessary information regarding this important part of farm management in clear, easy-to-follow directions, lavishly illustrated with plans and diagrams.

The subjects vary from the sharpening of tools and the use of rope on the farm to elaborate buildings for cattle, swine, horses, etc., and the best and most up-to-date construction for storing of crops. It also includes repair work as it relates to the farm-house itself.

Essential for the efficient and up-to-date farmer, this book will also be invaluable to every country dweller who wants to keep his place in the best possible shape, and to save money by making his own repairs.

HOUGHTON MIFFLIN COMPANY

$3.75

TRULY RURAL

By

Richardson Wright

A man and his wife (a most charming man, with a delightful wife) buy an old country house and undertake its rejuvenation. There are chapters about the fine art of breakfasting and the re-arranging of closets—lovely interior vistas of an old colonial stairway or a perfect dining-room, or outside orchards and radiant gardens.

There are many suggestions in this little book which will be of great value for all who love houses and gardens, and much valuable information. And all readers, with a grain of the proud householder in their blood, will ache at least to re-arrange the furniture or go out in the garden and dig.

Mr. Wright is well known as the Editor of *House and Garden.*

CONSTRUCTION AND REPAIR WORK FOR THE FARM

STRUCK

REFERENCE LIBRARY * HOUGHTON MIFFLIN CO. * BOSTON, MASS.
Archive Collection

This book may not leave the Offices and if borrowed must be returned within 7 days

CONSTRUCTION AND REPAIR WORK FOR THE FARM

BY

F. THEODORE STRUCK, PH.D.

ASSISTANT DIRECTOR OF VOCATIONAL EDUCATION
STATE DEPARTMENT OF PUBLIC INSTRUCTION
COMMONWEALTH OF PENNSYLVANIA

HOUGHTON MIFFLIN COMPANY

BOSTON NEW YORK CHICAGO SAN FRANCISCO

The Riverside Press Cambridge

COPYRIGHT, 1923

BY F. THEODORE STRUCK

ALL RIGHTS RESERVED

The Riverside Press

CAMBRIDGE · MASSACHUSETTS

PRINTED IN THE U.S.A.

EDITORS' INTRODUCTION

FARM construction and repair work has been during recent years rapidly finding a place as a part of the instruction in vocational agriculture of secondary grade. This work in its initial stages was naturally largely of the manual training type. Gradually there has been a growing recognition of the importance of centering the instruction in this phase of farming around the needs of the farm.

The author of this volume is peculiarly qualified to make a contribution to the more complete development of this aspect of vocational instruction in agriculture from this viewpoint. He made one of the pioneer studies dealing with the needs of the farmer for knowledge and skill in farm construction and repair work. In addition he brought to the preparation of this text an unusual background of trade experience, technical training, teaching and supervisory experience, and broad professional training.

The content is so organized that the teacher can easily correlate the instruction with any given phase of agriculture that the pupils may be pursuing, or it can readily be adapted to meet the demands of their home farms. This fact should make it possible for teachers to overcome the rather pronounced tendency that exists to make farm construction and repair work a course separate from the other courses in agriculture. It should be made an integral part of the instruction in agriculture.

The editors desire to direct attention to the fact that the material presented has been tried out in the author's classes at Pennsylvania State College, demonstrating its value as a text for students of agriculture. Unless otherwise indicated, the drawings are also the work of the author. In the organization of the teaching content of the several chapters an effort has been made to present it in order of the learning difficulties involved.

Teachers who use this as a textbook and others who may use it as a reference book should find the bills of materials and the directions of assistance to them. The author and editors will appreciate criticisms and suggestions from any who may use this volume.

GEO. A. WORKS
WM. S. TAYLOR

PREFACE

THE object of this book is to give concrete help to those who are interested in practical construction and repair work as it pertains to various kinds of farming. While the book has been written primarily for vocational agricultural students in secondary schools and colleges, it should also be helpful to farmers or others who are engaged in practical plant or animal production.

The projects have been arranged according to major divisions commonly observed in teaching technical agriculture. This has been done so that the shop instruction may readily be correlated with such major phases of agriculture as poultry husbandry or horticulture. Other things being equal, it is felt that the shop instruction should clearly reflect the major phase of agriculture that is being studied at the time.

An effort has been made to present the subject from a national rather than a sectional standpoint. Projects are included, therefore, that have been worked out in many States. In making the selections preference has been given to designs and to data that have demonstrated their worth, that have the approval of successful farmers and specialists, and for which there is more than a local demand.

The arrangement of this book is such that sections of it may well be used for short-unit courses of instruction. For this purpose such sections may be selected as are vital to the specific needs of the special groups of learners. For other classes instructors may wish to amplify or expand the material presented. This can be done by using the references contained in the text. It is hoped that students may have access to a good deal of this reference material.

Grateful acknowledgment is due to many former colleagues of the author at the Pennsylvania State College, to associates in the Pennsylvania State Department of Public Instruction, and to many teachers, directors, supervisors, and specialists. The author feels especially indebted to Mr. William S. Taylor, formerly Head of the Department of Rural Life, of the Pennsylvania State College, and now Assistant Director, the Teacher Bureau, Pennsylvania State Department of Public Instruction, and to Mr. L. H. Dennis, State Director of Vocational Education for Pennsylvania.

F. THEODORE STRUCK

CONTENTS

I. The School Shop 1

II. Tools for Construction and Repair Work 12

III. Sharpening Tools 27

IV. Materials commonly used 39

V. Relating to Vegetable Gardening 64

VI. Relating to Poultry Husbandry 93

VII. Relating to Field Crops 145

VIII. Relating to Horticulture 159

IX. Relating to Swine Husbandry 181

X. Relating to Cattle Husbandry 205

XI. Relating to Sheep Husbandry 213

XII. Relating to Horse Husbandry 228

XIII. Relating to Dairy Husbandry 236

XIV. Relating to General Farm Projects 253

XV. Relating to the Farm Home 286

XVI. Self-Made Equipment for the School Shop or for Home Construction and Repair Work 297

XVII. Sketching and Mechanical Drawing 333

XVIII. Uses of Rope on the Farm 342

XIX. Belt and Harness Repairing 353

Appendix A. Data concerning Strength of Materials . . 369

Appendix B. List of Publishers and Addresses of Experiment Stations 371

Index 375

CONSTRUCTION AND REPAIR WORK FOR THE FARM

FIG. 1. COMBINATION FARM SHOP AND GARAGE

Built by pupils of the Lampeter, Pa., Vocational School. W. N. Lowrey, Director.
(Photographs by W. N. Lowrey.)

CONSTRUCTION AND REPAIR WORK FOR THE FARM

CHAPTER I

THE SCHOOL SHOP

Purpose. Boys who study vocational agriculture should have access to a school shop. This shop should have facilities for instruction in such practical construction and repair work as successful farmers of the given locality undertake. In addition to instruction that can be given in such school shops every effort needs to be made to supplement this by similar work on the home farm or elsewhere.

While one purpose of the shop instruction is to give certain physical skills with tools and to impart technical knowledge that is needed, this is by no means the dominating aim. The school shop offers exceptional opportunities for developing good citizenship. In the handling of tools and materials, and in the execution of shop projects, pupils learn how to work and to think not only as individuals, but as members of a group. Fundamental ideals about work, coöperation with others, and the rights and welfare of the group are probably learned better in the shop than in the classroom.

Kinds of work that should be undertaken. The kinds of work that should be undertaken in a school shop depend upon the purpose of instruction. If it is purposed to give instruction primarily for appreciation and for vocational guidance, it may well be that shop projects can be included that would not be advisable if the instruction is to be vocational in nature. The opposite of this may also be true.

From the standpoint of vocational agriculture the shop projects undertaken should be such as successful farmers perform in the pursuit of their vocation. This differs somewhat in various sections of the country, and with the type of farming that is followed.

The successful teacher makes it a point not only to know the requirements of his community at large, but selects shop projects on the basis of the individual needs on each pupil's home farm, and from the standpoint of giving broad, useful training.

Farm blacksmithing. Farm blacksmithing can well be taught as an integral part of the course in construction and repair work in a composite shop as described under "Shop lay-out." For information relative to tools and materials to be used see the Index.

In the State of Pennsylvania [1] twenty per cent of the successful farmers use taps and dies, nineteen per cent shoe horses, or replace horseshoes, fourteen per cent have forges on their farms, weld and temper steel. The same percentages may not hold for other States, but it is probable that they are fairly typical of large sections of the United States.

With such data as a basis the conclusion is reached that relatively less

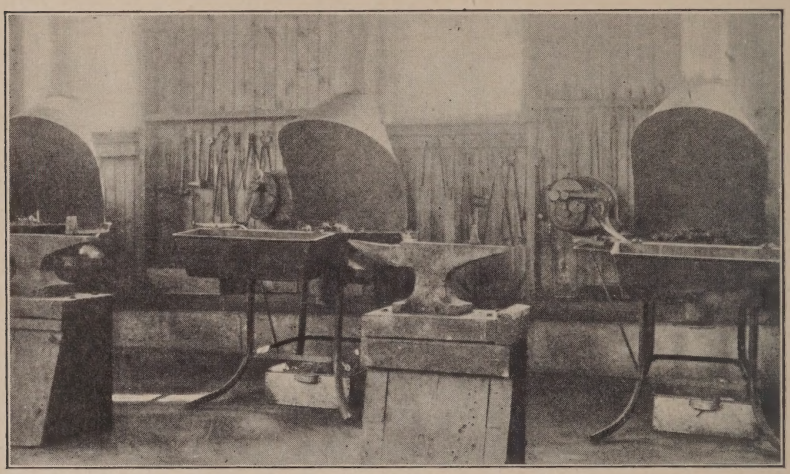


FIG. 2. INTERIOR VIEW OF A PART OF THE FARM SHOP AND GARAGE SHOWN IN FIG. 1

attention needs to be given to teaching farm blacksmithing than to teaching projects largely involving wood. This should not be taken to mean that farm blacksmithing is not essential to a well-balanced curriculum.

A great deal of farm blacksmithing should be in the nature of drilling, punching, cold and hot bending, and simple welding and tempering. Figures 9, 10, and 11 show typical farm blacksmithing, such as is being done in the vocational agricultural classes in Pennsylvania.

Farm blacksmithing should grow out of, and dovetail with the farm shop projects that are being carried out by the pupils. The iron work is therefore not listed separately in this book.

Work in concrete. Cement is used as a material of construction by thirty-one per cent of the successful farmers in Pennsylvania. It has grown rapidly in favor among farmers as well as with builders and engineers. Information regarding tools used in concrete work and data on proportioning and on methods of handling concrete are given elsewhere in this volume.

Cement is a valuable material of construction that is beginning to

[1] Struck, F. Theodore, *Farm Shop Work in Pennsylvania*. Special Bulletin No. 1, 1920. The Pennsylvania State College.

FIG. 3. SIDE VIEW OF A FARM SHOP

Built by the vocational agricultural class at Jameson, Mo. Mr. L. D. Crodrer, instructor. Photograph, courtesy of Mr. W. T. Spanton, State Supervisor of Agricultural Education, Jefferson City, Mo.

receive the attention it rightly deserves in courses in construction and repair work for agricultural students.

Leather work. In teaching farm shop work, attention should also be given to simple repair and construction work on harness, saddles, and belting. Basic training can be given in a short time, and should be a part of the modern curriculum for farm boys.

Rope work. Some instruction may well be given to the end that students may know how to make knots, hitches, and splices such as are used by farmers.

FIG. 4. ANOTHER VIEW SHOWING WIDE ENTRANCE DOORS OF SHOP SHOWN IN FIG. 3

Sheet-metal work. In a complete shop a little instruction in soldering and in pipe-fitting will prove of interest and value to students.

Materials to be used. An analysis of the construction and repair work done on 365 farms in Pennsylvania[1] shows that the bulk of such work is in wood, but that other materials such as concrete, and iron and steel are likewise used. In Pennsylvania seventy per cent of the farmers carry on general farming. In view of the fact that this is rather representative of the country at large, and from such data as there are available, it is certain that several materials of construction should be used in the school shop rather than limit the teaching to woodwork as is too frequently the case.

Cost of material. One argument sometimes advanced in favor of making small, miniature models of things is that material is expensive. This is true, but cost of material should prove no handicap. There are several ways in which material may be supplied without cost to the board of education. The first method is to have pupils or parents pay for all expensive material that is used in making or repairing objects that they keep upon completion. If shop projects are selected that fit in with educational requirements as well as with the needs of the home farm, there should be no difficulty in getting material with which to work. A second plan that is used in exceptional cases, as in the case of boys from town who do not live on farms, is to have them work on objects for other farmers, or for the school. If the objects are to be kept by the school, the material should be paid for out of school funds. A third method is to build such objects as self-feeders for hogs, or for poultry, as class projects, and sell them to farmers either on an individual order basis, or to the highest bidder at some school program to which parents and friends may be invited. Any of these methods or combinations of them may be used to advantage, and the actual cost of material to the local school district can be kept as low as circumstances may require.

Type of shop. The school shop that is most economical and at the same time satisfactory for rural districts is what may be termed the "composite" or "general" shop. By this is meant a shop that has several units of equipment for working materials such as wood, cement, iron, and leather, rather than equipment for only one kind of material such as wood or steel. Some of the advantages of the composite shop are as follows:

1. The composite shop is less expensive to equip than several separate unit shops which might be used to offer instruction in the same materials.
2. It provides a maximum of essential equipment for a minimum cost.
3. It makes possible a richer course of study than is possible in a one-unit shop.

[1] Struck, F. Theodore, *Farm Shop Work in Pennsylvania*. Special Bulletin No. 1, 1920. The Pennsylvania State College.

4. It provides the necessary equipment to give flexible courses of instruction.

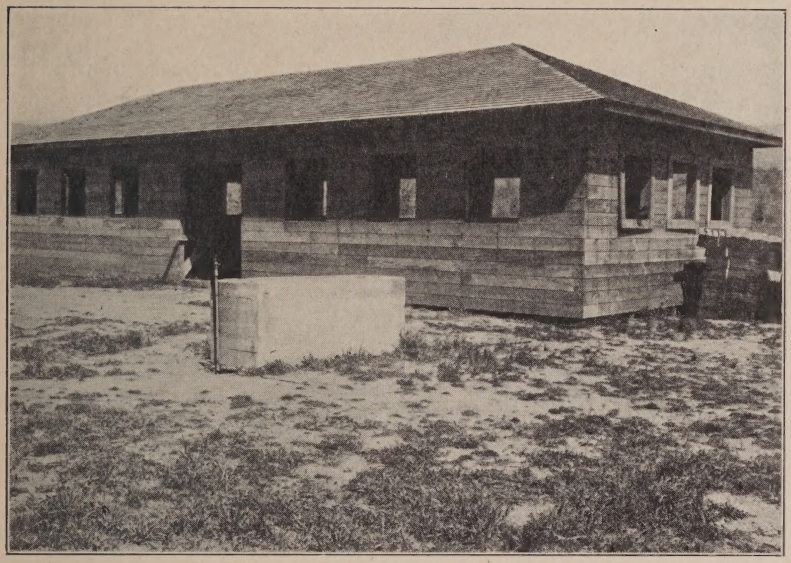


FIG. 5. A FARM SHOP BUILDING IN PROCESS OF CONSTRUCTION AT UPPER LAKE, CALIFORNIA

This building is being built by pupils under the direction of Mr. Arthur E. Mead. Photograph, courtesy of Mr. J. B. Lillard, State Supervisor of Agricultural Education, Sacramento, Cal.

FIG. 6. CLASS AT MOUND CITY, MO., WHO ERECTED THIS FARM SHOP BUILDING IN TWO WEEKS

Mr. H. G. Tilly, instructor. Photograph, courtesy of Mr. W. T. Spanton, State Supervisor of Agricultural Education, Jefferson City, Mo.

5. It sustains interest on the part of learners because projects can be completed even though they involve several different kinds of material, such as wood and steel. It therefore makes for effective instruction.
6. The composite shop may well be used for purposes of industrial arts education as well as for vocational agricultural instruction.

Shop lay-out. From a practical standpoint, it is recognized that in many instances the lay-out of the shop as far as size and location are concerned is definitely fixed. The teacher can simply adapt the available space to his needs as best he may. Whenever possible the shop should have an outside ground floor entrance, and a door wide enough to admit farm machinery upon which work may need to be done.

It is often satisfactory to place shop benches along the walls of the shop so that the central floor space can be used for assembling, or for work of other kinds.

The wood-working equipment can be grouped in one part of the shop, the metal-working equipment in another, while still other parts are reserved for concrete, sheet-metal, or leather work. The amount of space devoted to each of these need not be very large since the idea is to have just enough equipment for a class of not over twenty pupils. Not all pupils will be working with any one material at a given time, so that instead of having equipment for twenty pupils in wood-working, the shop can contain equipment for ten. Instead of a separate forge room with equipment for twenty pupils, the composite shop may contain one or two forges only. Near these there may be a metal-working bench equipped with a blacksmith's vise, and a machinist's bench vise. Work with taps and dies can also be done on this bench. About three pupils can work at such a bench to advantage. In another part of the shop, not far away, there may be a pipe vise fastened either to a bench, a post, or to a portable horse. Here simple pipe-fitting work can be done by two or three of the pupils. Still another part of the shop can be used for cement work, and some harness repairing and rope work can be taught elsewhere in the same shop. In this way a class of twenty pupils may be given basic instruction in practical construction and repair work that is worth while to the extent pursued, and which does not need to be justified in terms of deferred values that may be claimed for such instruction. The pupils should select projects which will assure good training with all the equipment in the shop.

Size of projects to be undertaken. Farm boys should be taught to do the work that arises in practical farming. The projects should have real value in the minds of the pupils as well as in the teachers' estimation. Small models of things should be discouraged in favor of full-sized jobs. A boy may get certain skill and knowledge from making a small model of a farm gate, but he will get better and more effective instruction for farming by making a full-sized gate 14 feet long. Planing

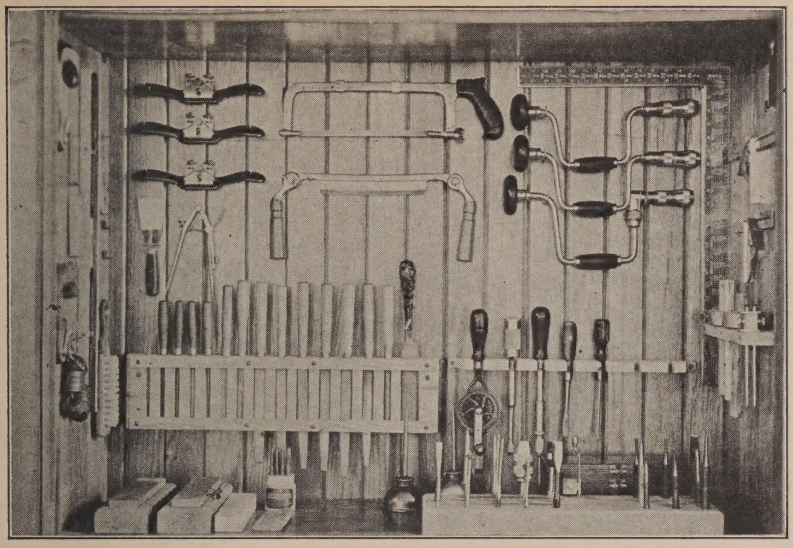


FIG. 7. INTERIOR VIEW OF PART OF "GENERAL" TOOL CABINET IN THE FARM SHOP AT THE PENNSYLVANIA STATE COLLEGE

a board 14 feet long is quite different from planing a board 1 foot long, and using real bolts and hinges is different from using miniature imitations.

Standards of workmanship. The standards of workmanship for repair and construction work that is taught as a part of the vocational agricultural curriculum should be the same as those that obtain for this work in good farm practice. It needs to be kept in mind that the funda-

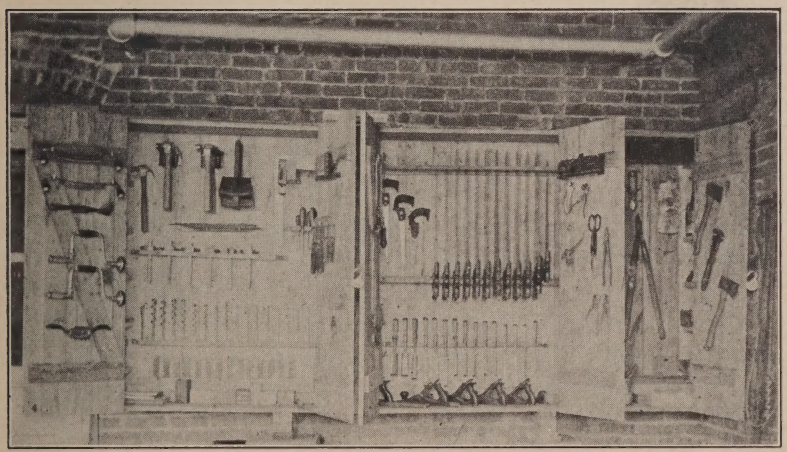


FIG. 8. SHOWING ARRANGEMENT OF TOOLS USED IN TEACHING FARM SHOP WORK IN A SCHOOL IN THE STATE OF NEW YORK

Photograph, courtesy of Mr. A. R. Getman, Specialist in Agricultural Education, State Department of Public Instruction, Albany, N.Y.

mental purpose is to prepare for successful farming, and not for carpentry, cabinet-making, blacksmithing, or garage work.

Method in teaching construction and repair work. Both the subject-matter of instruction and the method of teaching should be governed by fundamental educational considerations. The instruction should aim to

a. Develop skill in construction and repair work.
b. Give information about tools, processes, materials, and designs used in construction and repair work.
c. Develop in pupils initiative and the power to think independently.
d. Guide pupils that their thoughts and acts are truly social and not narrowly selfish.

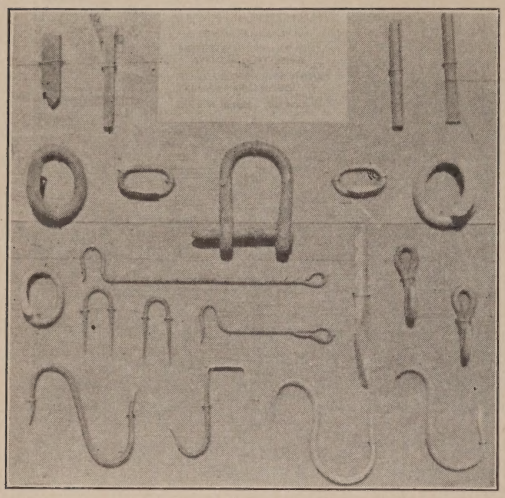


FIG. 9. FARM BLACKSMITHING DONE AT NORWIN UNION HIGH SCHOOL, IRWIN, PA.
Mr. C. H. Perkins, instructor.

e. Develop the spirit of coöperation.
f. Lead pupils to have the problem-solving attitude.

The project method is one that is particularly well adapted to the realization of the aims stated for the following reasons:

a. It offers opportunity for individual purposing and planning.
b. It enlists, at the outset, the pupil's interest in the thing to be done, or act to be performed.
c. It gives opportunity for, and in many cases requires coöperation; it involves the opposite of the "stay at your bench and do as you are told" method.

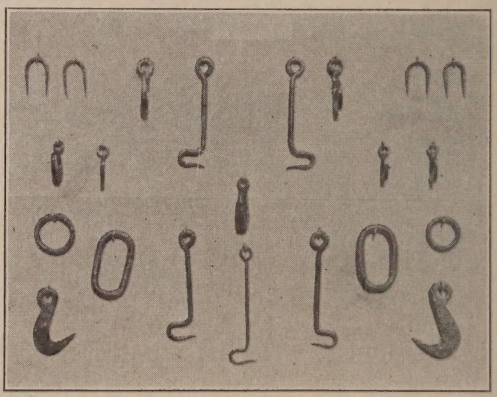


FIG. 10. FARM BLACKSMITHING DONE AT THE GREEN DREHER VOCATIONAL SCHOOL, NEWFOUNDLAND, PA.
Mr. J. Jacobs, instructor.

d. The method is pedagogically superior to the exercise method of shop instruction in that the psychological rather than the so-called logical order (as conceived by trained adult minds) is followed.

e. It emphasizes immediate as distinguished from deferred values. To put it tersely, it involves a minimum of "cold storage" process.

The project method in farm shop work is analogous to the same method in technical agriculture. It requires the pupil under guidance to take the initiative in purposing a given piece of work that he later plans and executes. The pupil keeps records of time and material and seeks to develop general truths from the specific work undertaken.

Projects in farm shop work cannot be as large in terms of time or labor required as can projects in a major enterprise in farming, such as crop or animal production. They must be limited to the time allowed for such work in the general plan of agricultural education.

Shop equipment. The minimum amount of equipment that will be needed for effective instruction must necessarily vary. Some States can require more equipment in their schools than others. The list given in Table 1 is to be considered merely as a suggestive list for a composite shop.

TABLE 1. MINIMUM EQUIPMENT SUGGESTED FOR SCHOOL SHOP[1]

I. WORK IN WOOD (*required*)

(Other makes of equipment of equivalent grade may be substituted for items specified.)

ITEM	AMOUNT	DESCRIPTION
1	1	Brace 10″, Millers Falls Co. No. 322 (Barbers).
2	1	Set bit, auger, R. Jennings No. 32½, ¼″ to 1″ by 16ths inch, Bartlet Box.
3	8	Bit-stock drills, 2 each ⅛″, 3/16″, ¼″, one each ⅜″, ½″.
4	1	Each, bit, countersink, gimlet Nos. 0, 1, 2.
5	1	Bit, expansive, Wright No. 10, with No. 3 and No. 4 cutters, bores ⅞″ to 3″.
6		Bit, screwdriver, 1 each ⅜″, ½″.
7	1	Carborundum stone No. 108, 8″ × 2″ × 1″. Combination faces, medium and fine.
8	1	Carborundum slip stone No. 101, 4½″ × 2⅛″ × ⅝″–5/16″ medium.
9	12	Chisels, Buck Bros. or "Keen Kutter," beveled edge, socket, firmer, 2–¼″, 1–⅜″, 3–½″, 1–⅝″, 3–¾″, 1–1″, 1–1¼″.
10	1	Countersink, Rose No. 20, bit-brace shank.
11	1	Drawing knife, Witherby 8″.
12	1	Divider, Starrett No. 92 with wing and extension leg.
13	1	File, auger-bit.
14	6	File, Hunt's Chrome special three-square, 5″ (Disston).
15	6	File, Disston's three-square 5″ regular taper.
16	1	Glass cutter, No. 10, turret head, 6 wheels.
17	1	Grinder, carborundum No. 4, wheels, 7½″ × 1¼″, one each, medium and fine. Foot power attachment.
18	*N	Hammer, Atha, Maydole or Hammond adze-eye, bell-faced, nail hammers, weight 16 oz. Curved claw.
19	1	Hand axe, Hammond No. 2, 4½″ handled.
20	1	Level, Stanley No. 13, adjustable, 30″ long, brass tips.
21	3	Nail sets, Syracuse, cup point, assorted sizes.
22	1	Oiler, drawn steel, copper plated, 3½″ diameter, 5″ spout.
23	1	Plane, block Stanley No. 103, 5½″ × 1⅝″ lever adjustment.
24	**N/2	Plane, smooth, No. 4 Bailey, iron, 9″ × 2″, smooth bottom.
25	**N/2	Plane, jack, No. 5 Bailey, iron, 14″ × 2″, smooth bottom.
26	1	Plier, Utica combination, No. 25.
27	1	Putty knife, H. S. Co. No. 1540, flexible 2″ blade.
28	1	Reamer, Syracuse No. 12, 1/16″ to ⅜″ × 5¾″.

[1] Struck, F. Theodore, *Farm Shop Work in Pennsylvania*. Special Bulletin No. 1, 1920. The Pennsylvania State College.

Item	Amount	Description
29	*N	Rules, Stanley No. 53, 2 ft. 4 fold, 1″ wide.
30	1	Saw, cross-cut, Disston, 8D, 8 point, 26″.
31	2	Saw, cross-cut, Disston, 12D, 10 point, 22″.
32	3	Saw, cross-cut, Disston, 12D, 10 point, 24″.
33	2	Saw, rip, Disston, 8D, 5½ point, 26″.
34	1	Saw, compass, Disston, No. 2, 14″.
35	1	Saw, coping, Griffin No. 110, with 1 doz. blades.
36	1	Saw-set, Morril No. 10.
37	1	Saw-jointer. (Made by pupils.)
38	1	Saw clamp. (Made by pupils.)
39	1	Saw file handle. (Made by pupils.)
40	1	Screwdriver, Yankee No. 95, 2½″ blade, slim.
41	1	Screwdriver, "Hurwood" No. 20, 4″ blade, regular.
42	1	Screwdriver, "Hurwood" No. 40, 7½″ blade, cabinet.
43	1	Sliding T bevel, Disston No. 3, 6″.
44	1	Square, framing, Nichols No. 100A. Body 24″ × 2″, tongue 16″ × 1½″.
45	1	Framing square, Stanley No. R 100N. Body 24″ × 2″, tongue 16″ × 1½″.
46	**N/2	Square, try, Stanley No. 12, 6″ blade.
47		Screw, bench, wrought iron, 1″ diam., 15″ long.
48	1	Vise, blacksmith's solid box, No. 40, 4″ jaw.
49	1	Wrench, Coe's monkey, 8″ perfect handle.
		Additional desirable equipment
1	1	Brace, 12″, Millers Falls Co. No. 322. (Barber.)
2	1	Chuck, Millers Falls Co., Star Chuck, No. 17, capacity 0″–½″ bit-stock shank.
3	1	Hack saw, Millers Falls Co. No. 1101. Capacity 8″ to 12″, with 1 doz. 10″ blades.
4	1	File, flat, bastard cut, 8″.
5	1	File, half round, bastard cut, 8″.
6	1	File, cabinet rasp, 12″.
7	1	File, bastard cut, 10″ round.
8	1	File, mill, 8″ single cut.
9	1	Set cross-cut saw tools, Disston, "Imperial."
10	1	Pair level sights, Stanley No. 2.
11	1	Tape, 50 ft. Lufkin's Universal No. 1033, ½″ corded linen tape graduated in fourths.
		II. Work in Iron and Steel (*required*)
1	1	Breast drill, Millers Falls Co. No. 87, for bit-stock shanks and round shank drills.
2	3	Cold chisels, 1 each, ⅜″, ½″, ⅝″.
3	1	Hack saw, Millers Falls Co. No. 1011, capacity 8″ to 12″, with 1 doz. blades 10″ long.
4	1	Hammer, Atha, ball pene, 10 oz.
5	1	Punch, center, machinist's octagonal ⅜″.
6	1	Set screw plates, Russell No. 11, taper taps, dies and collets cutting, ¼–20; 5/16–18; 7/16–14; ½–13.
7	1	Wrench, Coe's monkey, 8″ perfect handle.
8	1	Wrench, Coe's monkey, 10″ perfect handle.
9	1	Wrench, alligator, No. 1, 5⅝″.
		Additional desirable equipment
1	1	Anvil, Hay-Budden, 100 lb. 3⅝″ × 12½″ face, 9″ horn, Hardie hole ¾″, Pritchet hole 7/16″.
2	1	Chisel, cold Atha, No. 1290, 2 lb.
3	1	Chisel, hot Atha, No. 1300, 1¼ lb. 6″ long.
4	1	Forge, Lancaster Blower and Forge Co. No. 408, hearth 30″ × 36″, fan 12″ diam., water tank and half hood.
5	1	Hammer, Atha, 1½ lb., ball pene.
6	1	Hammer, Atha, 2 lb. blacksmith's No. 1, 18″ long.

*N — Quantity of tools equal to the number of pupils in the class.
**N/2 — Quantity of tools equal to half the number of pupils in the class.

Item	Amount	Description
7	1	Hardie, Atha, ¾″ blade 1⅞″.
8	1	Pair tongs, Atha No. 11, "V" notched jaws for ¼″ stock, 18″.
9	1	Pair tongs, Atha No. 12, bolt tongs, 18″.
10	1	Pair tongs, Atha No. 10, straight lip, 18″.
11	1	Pair tongs, Atha No. 16, general forging, flat jaws.
		III. Pipe-Fitting (*optional*)
1	1	Cutter, Armstrong's improved No. 2 B. Capacity ½″ to 2½″.
2	1	Oiler, drawn steel, copper plated, No. 1113A; diam. 3½″.
3	1	Stock and die, Armstrong's adjustable, cutting pipe, sizes ½″, ¾″, 1″, 1¼″, 2″ right and left.
4	1	Vise, Armstrong's No. 0. Capacity ⅛″ to 2½″.
5	1	Wrench, Stillson, 10″, steel handle.
6	1	Wrench, Stillson, 18″, steel handle.
		IV. Work in Cement (*required*)
1	1	Edger, No. 1, 6″ × 3″, ⅜″ radius.
2	1	Jointer, No. 25, 9″ × 3″.
3	1	Square angle tool, outside, No. 31, 8″ × 2¼″.
4	1	Square angle tool, inside, No. 32, 8″ × 2¼″.
5	1	Trowel, cementer's (Disston), No. 20, 11½″ × 4 13/16″.
6	1	Trowel, pointing (Disston) No. 15, 5″ long.
		V. Soldering and Babbitting (*optional*)
1	1	Chisel, Syracuse, half round nose, ½″.
2	1	Chisel, H. S. Co., plugging, ⅝″.
3	1	Gasoline torch, Clayton and Lambert No. 32. Or
	1	Gas furnace, Pexto No. 973, single burner.
4	1	Shave hook, triangular.
5	1	Pair snips, Reliance or Pexto, No. 8, 3½″, left hand cut.
6	2	Soldering coppers, 1 lb. each.
		VI. Drawing Equipment (*required*)
1	3	Boards, white pine 20″ × 26″ × 13/16″, with end ledge flush with surface of boards.
2	3	Compasses, pencil, at about 30 cents each.
3	3	T squares, pearwood blades 30″ long, fixed heads.
4	3	Triangles, Dieztgen's No. 8803, 6″, 45°, amber.
5	3	Triangles, Dieztgen's No. 2021, 8″, 60°, amber.
6	3	Scales, architect's, triangular 12″, boxwood.
		Additional desirable equipment
7	1	Boston pencil sharpener.
8	1	Eraser shield brass, nickel plated.
9	1	Pair paper shears, 10″.
10	1	Yardstick, maple.
11	1	Set instruments, Dietzgen's No. 833, containing ruling pen, bow pen, compass and attachments.
		VII. Work in Leather (*optional*)
1	1	Awl, Stewart's automatic sewing, with No. 8 needles, straight and curved.
2	1	Awl, harness-maker's collar or drawing 8″.
3	1	Awl, haft, "Stanley's" No. X6, 4″.
4	1	Edging tool, 5″ long.
5	1	Knife, leather, 4″ blade.
6	1	Knife, harness-maker's round, 5″ blade.
7	1	Paper needles, harness-maker's assorted.
8	1	Rivet set, No. 1, H. S. Co.
9	1	Rivet set, No. 2, H. S. Co.
10	1	Spring punch, 4 tubes, Nos. 4, 6, 8, and 10, H. S. Co. No. 126A.
		VIII. General (*desirable*)
1	1	Fire extinguisher, Pyrene, brass finish, with wall bracket for support.
2	1	First aid cabinet, Johnson & Johnson, large size.
3	1	Oily waste can, New York pattern, No. 3, 12⅞″ × 17½″ with self-closing lid.

CHAPTER II

TOOLS FOR CONSTRUCTION AND REPAIR WORK

THERE is as much difference in design and utility for given purposes in most tools intended for construction and repair work as there is in plows or in cream separators. Hand tools like farm machinery have become somewhat standardized. The following descriptions are given in order to aid persons in selecting tools that are suited to the needs that arise on the farm.

A. Tools for working wood.

1. The brace illustrated in Fig. 13 is used for boring wood with auger bits, for drilling wood or metal with twist drills, for

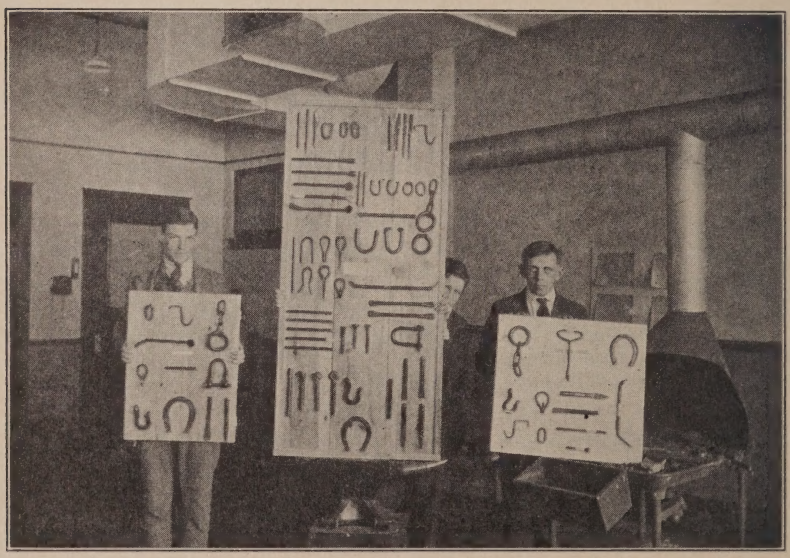


FIG. 11. FARM BLACKSMITHING DONE BY PUPILS AT TOWANDA, PA.
Mr. B. A. Rockwell, instructor. Photograph, courtesy of B. A. Rockwell.

reaming, and for driving screws where more power is needed than can be applied with a screwdriver.

Braces are made either with or without ratchets. A ratchet is an attachment (usually enclosed on a brace) which permits the operator to use only a part of the "swing" if he desires, as is sometimes necessary in boring holes in places where access is difficult, or the working room is limited. This may happen in case a hole needs to be bored in a place in which there is little access or working room.

By the "swing" of a brace is meant the diameter of the dis-

tance through which the hand passes in one complete revolution or turn of the brace. For example, a brace having a ten-inch swing will measure five inches from the center of the handle used for turning the brace to the center line of the bit or drill used. A ratchet brace having a ten-inch swing will be found very desirable.

2. *Bits and drills.* The auger bits commonly used in braces are made in sizes varying by one sixteenth of an inch. Common sizes run from three sixteenths of an inch to one and one-half inches. Farmers are likely to need most of the following sizes: ¼″, ⅜″, ½″, ⅝″, ¾″, 1″. The diameter of auger bits is stamped on the shank in terms of sixteenths. For example, 10 stands for ten sixteenths. For larger sizes it is desirable to have an expansive bit which may be adjusted to cut from seven eighths of an inch to three inches.

   Twist drills may be purchased in varying diameters and with bit-stock shanks which fit the brace.

   For driving large screws it is well to have a screwdriver bit with a bit-stock shank.

   Gimlet bits are available with bit-stock shanks. A combination gimlet bit and countersink are also obtainable. It is useful when a number of screws of a given length and diameter are to be used.

3. *Carborundum and oilstones.* Carborundum stones are made in a number of shapes and sizes and in various degrees of fineness. They are very good as tools may be sharpened more quickly on them than on oilstones. Carborundum stones act quickest when used dry, that is, without oils. A carborundum stone 8″ × 2″ × 1″ with combination faces (two of different degrees of fineness) is handy and useful.

   Oilstones likewise are made in a number of shapes and sizes, and vary in hardness and fineness. A light lubricating oil, or one part kerosene to two parts light motor oil works nicely on oilstones.

4. *Chisels.* Chisels are made with tanged and with socket handles. The latter hold up best under heavy usage such as they frequently get on the farm. For general farm use firmer socket chisels with leather or with metal tips are desirable. The sizes likely to be most in demand are ¼″, ½″, and 1″.

5. *Drawing knife.* A drawing knife having an eight-inch blade will save labor at times. It is ordinarily not as necessary as are saws, planes, and other tools that might be mentioned.

6. *Files.* The majority of farmers could use to advantage a greater variety of files than they ordinarily possess. Files are so cheap that it pays to have several different kinds on hand.

The following deserve special attention:

a. Mill file, single cut, 8″ or 10″
b. Three-square file 5″ special for cross-cut hand saw
c. Three-square file 5″ regular taper for rip-cut hand saw
d. Auger-bit file
e. Cabinet or wood-working rasp, 8″ or
f. Half-round bastard cut file, 8″

7. *Grinder or grindstone.* Carborundum or other bench grinders,

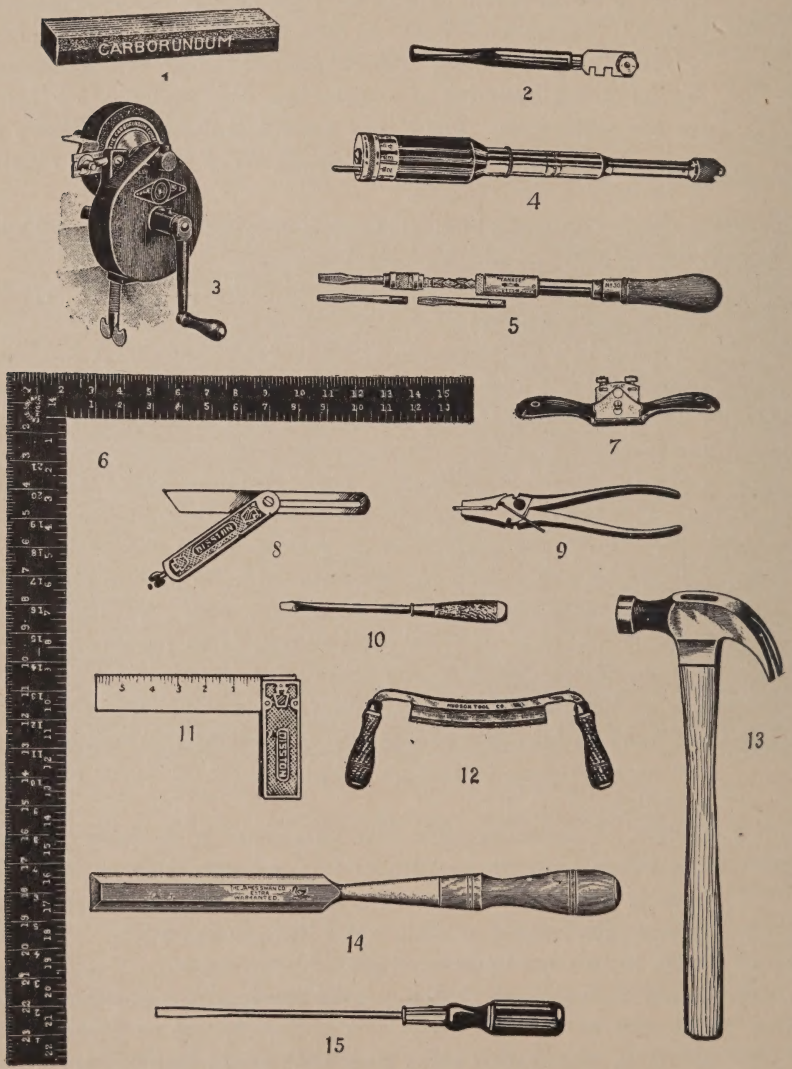


FIG. 12. WOOD-WORKING TOOLS

1. Carborundum stone. 2. Glass cutter. 3. Carborundum bench grinder. 4. Push drill. 5. Ratchet screwdriver. 6. Framing square. 7. Spoke shave. 8. T bevel. 9. Pliers. 10. Screwdriver. 11. Square. 12. Drawing knife. 13. Claw-hammer. 14. Socket firmer chisel. 15. Slim screwdriver.

that is grinders that fasten to work benches, are desirable. Tools can be sharpened more quickly on them than on sandstone grindstones. The latter are cheaper and last longer as a rule, but either may be used to advantage on the farm.

8. *Hammers.* Claw-hammers are made bell-faced and flat-faced.

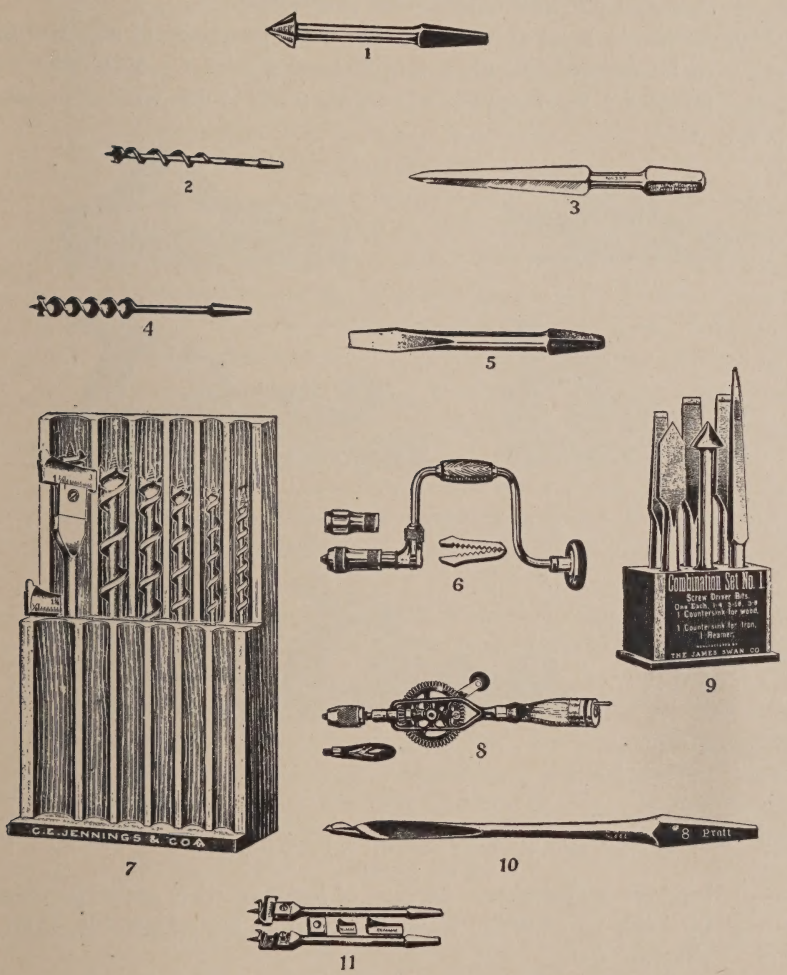


FIG. 13. BORING, DRILLING, AND REAMING TOOLS

1. Rose countersink. 2. Solid center, extension lip auger. 3. Square reamer. 4. Extension lip auger. 5. Screwdriver bit with bit-brace shank. 6. Brace with alligator jaws and ratchet. 7. Set of auger bits. 8. Hand drill. 9. Combination set. 10. Gimlet bit, bit-brace shank. 11. Expansive bit.

The slight crown on the bell-faced hammer tends to keep the wood from being cut in case the hammer misses the nail head or the latter is driven in below the surface of the wood. Adze-eye bell-faced claw-hammers are recommended because the adze-eye strengthens the handle. Either a curved claw or a straight

claw-hammer may be used. One weighing about 16 ounces will give satisfaction for all-round work.

9. *Hand axe, or hatchet.* Either a hand axe or a hatchet will prove to be of considerable service in a variety of construction and repair work on the farm. A hand axe having a blade four or four and one-half inches wide is satisfactory.
10. *Level.* A level is indispensable when buildings of any size are to be erected, or when establishing grades for sidewalks and terraces. For farm use a level about 30″ long, with adjustable

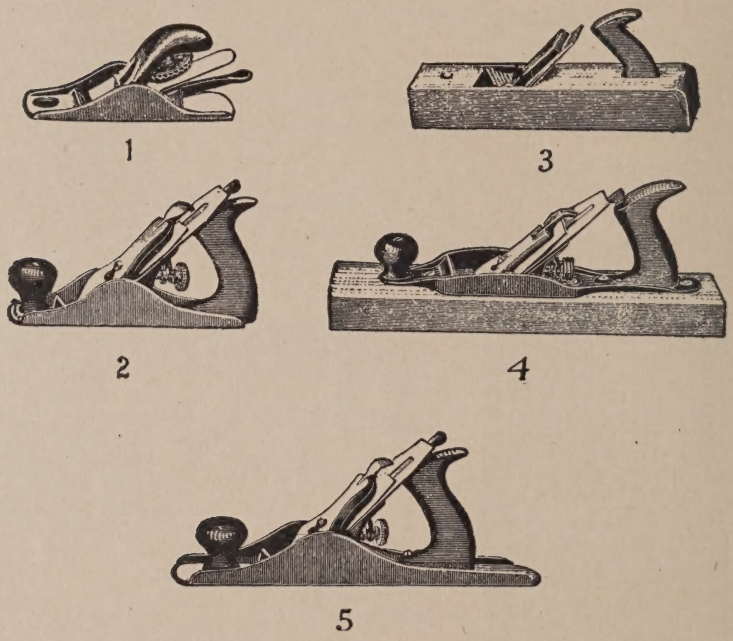


FIG. 14. TYPES OF PLANES

1. Block plane. 2. Bailey smooth plane. 3. Wood bottom jack plane. 4. Wood bottom jack plane with metal adjuster. 5. Bailey jack plane.

bubbles is desirable. In case of breakage it is easier to "true-up" the new bubble when the fittings are adjustable, than if they are not.

11. *Nail set.* Nail sets are made with different sized points varying from those designed to set very thin brads or nails to spikes. The cup-pointed nail sets are preferred for the smaller brads and nails as the "cup" on the end of the set tends to slip less and therefore will "follow" brads and nails better than will a flat-pointed nail set.
12. *Planes.*
    a. *The block plane.* Block planes are small planes made of iron or steel. They usually vary in length from 3½ to 7½ inches,

and in width of cutting blade from 1¼ to 1⅝ inches. Block planes are used primarily for planing end-grain — that is, across the grain of lumber. For this reason it is desirable that block planes have their plane blade set at a lower angle than smoothing planes. Some block planes have their blades at lower angles than do others. Since block planes are also used for gouging out irregular surfaces, it is well to have such planes in rather small sizes. An adjustable throat in a block plane is not necessary for the ordinary work of the farm. A lever or screw by means of which the depth of the blade can readily be regulated is desirable.

b. *Planes for smoothing and jointing.* From the standpoint of construction there are three principal kinds of planes that are used for plane surfaces. The first of these is the wood bottom plane, with wood wedges to hold the plane blade in place. This style of plane was used for many years but is not as satisfactory as either of the two styles about to be described, largely because it takes more time to adjust it and more time to sharpen it since the blades are thicker than in later styles of planes.

The second style is that having a wood bottom with an iron or steel throat and adjusting screws. It is an improvement over the wood bottom plane. It costs less than the iron plane.

The third style of plane is made almost entirely of metal, the knob and handle alone being of wood. The Bailey and the Stanley Bed-rock planes illustrate the construction. See Fig. 14. This style of plane is probably the best on the market. The price is high, but not more so than other planes when durability and service are considered. Adjustments are easy to make in these planes. Either plain or corrugated bottoms may be had in the iron planes. There is little difference between them.

Sizes of Iron Planes

Note: These sizes vary somewhat according to the make, and wood planes differ in size from those of iron.

Type of Plane	Length (in inches)	Width of Cutter (in inches)
Block.....	3½ to 7½	1¼ to 1⅝
Smooth....	5½ to 10	1¼ to 1¾
Jack.....	14 to 15	2 to 2¼
Fore.....	18	2⅜
Jointer.....	22 to 24	2⅜ to 2⅝

The accompanying table gives the sizes of iron planes. It will be noticed that different names are used for planes of cer-

tain sizes. If a farmer has a block plane and a jack plane he can get along without the others. If he is mechanically inclined and has considerable use for planes he may want to add a smooth plane to his tool kit.

13. *Saws.* Hand saws are made in a variety of styles and for special purposes, as for example, for pruning and for cutting meat. Hand saws used for repair and construction work on the farm

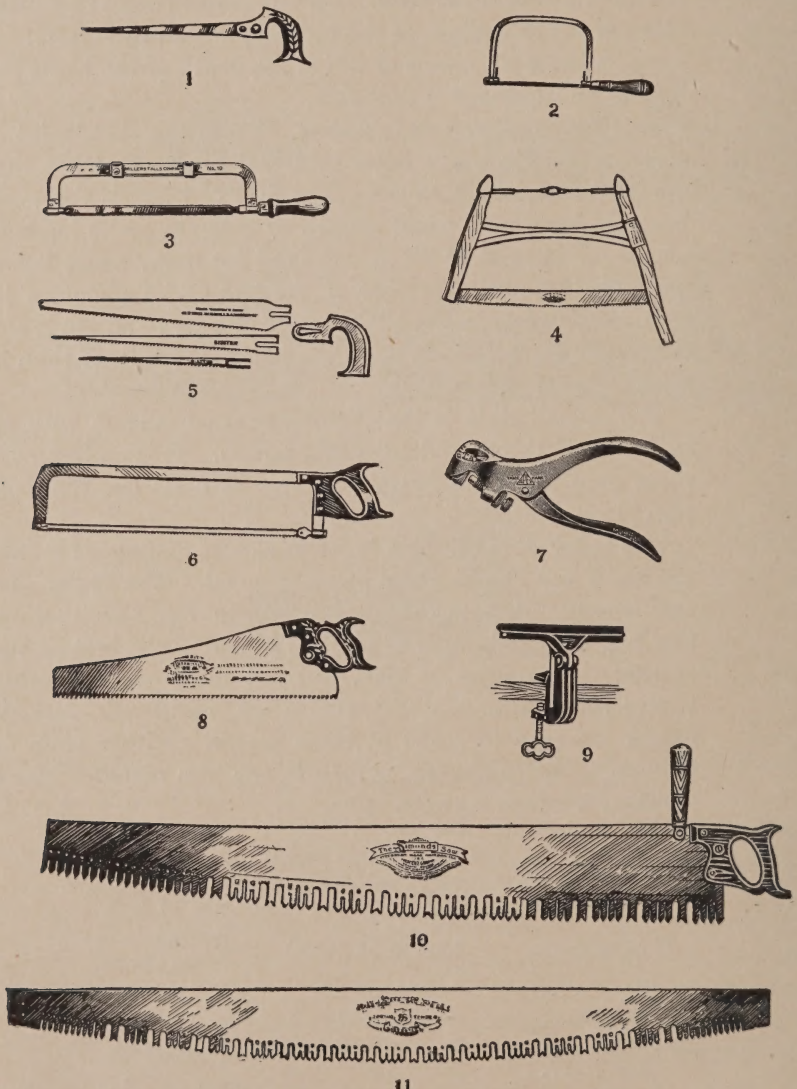


FIG. 15. SAWS AND SAW-SETS

1. Compass saw. 2. Coping saw. 3. Hack saw. 4. Bucksaw 5. Nest of saws. 6. Butcher's saw. 7. Hand saw-set. 8. Hand saw. 9. Saw vise. 10. One-man cross-cut saw. 11. Two-man cross-cut saw.

may be grouped into two classes, namely, cross-cut saws and rip-saws. Cross-cut saws have teeth specially designed to cut easily across the grain of lumber while rip-saws have teeth made specially for ripping, that is cutting lengthwise of boards or with the grain of lumber.

Cross-cut, rip-saws, and sharpening devices for them will be discussed more fully under "Fitting or filing saws." For general farm work an eight or ten point cross-cut saw 26 inches long is desirable. A rip-saw may well be 5½ to 7 point, and 26″ long. By "point" is meant the number of tooth points per inch of blade.

Back saws are not suited for general work such as farmers have to do.

14. *Squares.* The standard framing square as used by carpenters is the best all-round square for farm use. Framing squares have a blade 24″ long by 2″ wide, and a tongue 16″ long and 1½″ wide. The cheaper squares are made in bright steel finish. They will give good service if kept oiled so that rust does not get on them.

A try-square is a smaller square which is handy when narrow lumber, such as flooring, ceiling, and sheathing is to be squared off. A try-square made entirely of metal and having a 6″ or 8″ blade makes a good tool of this kind.

For those who desire an additional square a combination square with a ten or twelve inch blade is recommended.

The following is a suggestive list of wood-working tools that usually are needed on the farm. This list as others given may be added to or may be reduced as circumstances may warrant. It will be appreciated that no two farmers will want to purchase exactly the same outfit of tools.

List of tools for work in wood

Item	Amount	Description
1	1	Brace, ratchet, 10″ swing.
2	1 each,	Auger bits, ¼″, ½″, 1″.
3	1 each,	Bit-stock twist drills, ⅛″, 3/16″, ¼″, ⅜″, ½″.
4	1	Expansive bit, ⅞″ to 3″ cutters.
5	1	Bit-stock screwdriver bit, ½″.
6	1	Carborundum or oilstone 1″ × 2″ × 8″ combination faces.
7	1 each,	Chisels, socket, firmer, ¼″, ½″, 1″.
8	1	Countersink, rose, bit-brace shank.
9	1	File, auger bit.
	1	File, three-square, extra slim taper, 5″.
	1	File, regular taper, 5″.
	1	File, mill, single cut, 8″.
	1	File, half-round, bastard cut, 8″.
10	1	Hammer, adze-eye, bell-face, 16 oz., curved claw.
11	1	Hand axe, 4½″ handled.
12	1	Plane, block, low angle, 5½″ × 1⅜″, lever adjustment.
13	1	Plane, jack, 14″ × 2″ smooth bottom, iron.
14	1	Plier, combination, 5″.
15	1	Saw, cross-cut, 10 point, 26″.

Item	Amount	Description
16	1	Saw, rip, 5½ point, 26″.
17	1	Saw, compass, 14″.
18	1	Saw-set.
19	1	Screwdriver, 4″ blade, regular.
20	1	Square, framing, blade 24″ × 2″, tongue 16″ × 1½″.

B. Tools for cement and concrete work.

Few tools are needed for cement or concrete work done on farms. For sidewalk work or for making concrete feeding floors an edger and a jointer are desirable. A cementer's trowel, a pointing trowel 5″

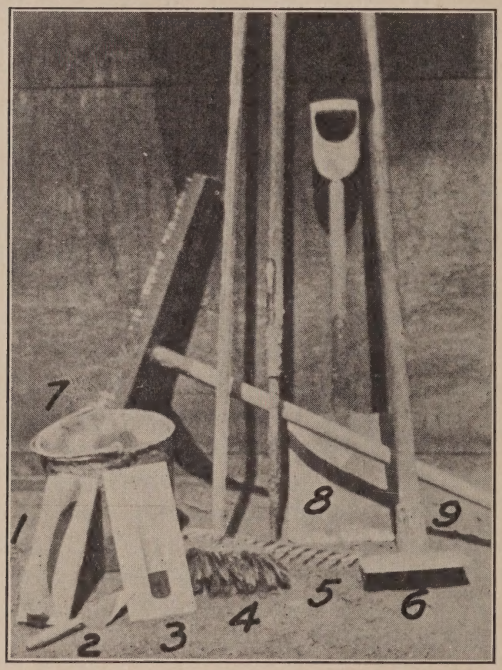


Fig. 16. Some Tools used in Cement Work

1. Wooden float (home-made). 2. Pointing trowel. 3. Cementer's trowel. 4. Brush. 5. Rake. 6. Tamper. 7. Pail. 8. Mixing shovel. 9. Long handled float (home-made).

long, and a whitewash or cement worker's brush are usually all the special tools that a farmer may need. The following list is suggestive:

List of tools for work in cement and concrete

Item	Quantity	Description
1	1	Edger, 6″ × 3″, ⅜″ radius.
2	1	Jointer, 9″ × 3″.
3	1	Square angle tool, outside, 8″ × 2¼″.
4	1	Square angle tool, inside, 8″ × 2¼″.
5	1	Trowel, cementer's, 11½″ × 4 13/16″.
6	1	Trowel, pointing, 5″.
7	1	Whitewash or cementer's brush.
8	1	Wooden float.

Note: Shovels, spades and wheelbarrows are not listed here as they are a part of the general farm equipment.

C. Tools for pipe-fitting.

Steam and water, and in some sections gas, are finding their way to the farmsteads. Farmers should be able to make the common repairs, and do simple construction jobs with pipe. The tools required for this are not many, and will prove a good investment, as much damage may result through lack of timely repair work.

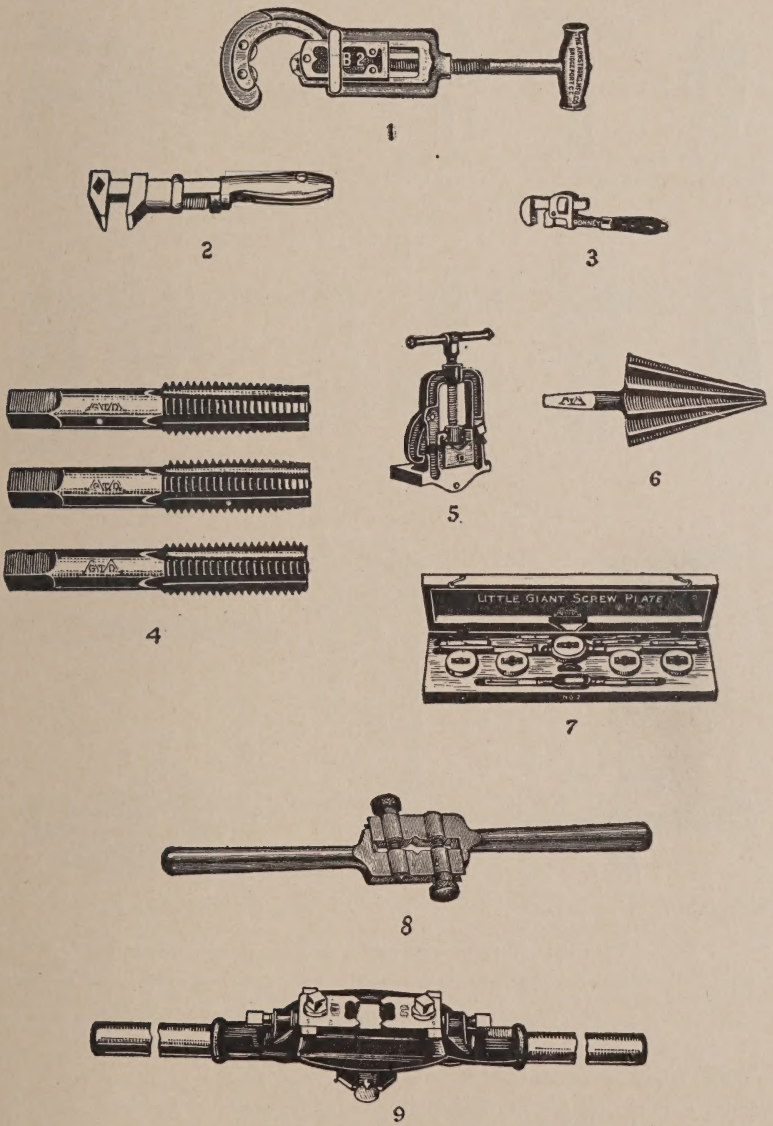


FIG. 17. TOOLS FOR PIPE-FITTING

1. Pipe cutter. 2. Monkey wrench. 3. Stillson wrench. 4. Hand taps; taper, plug, and bottoming. 5. Pipe vise. 6. Straight fluted burring reamer. 7. Screw plate. 8. Tap wrench 9. Pipe stock with dies.

List of tools for pipe-fitting

Item	Quantity	Description
1	1	Pipe cutter, ½″ to 2½″ capacity.
2	1	Oiler, 3½″ diameter, 5″ spout.
3	1	Set of stock and dies, cutting pipe sizes ½″, ¾″, 1″, and 1¼″, right hand.
4	1	Pipe vise, capacity ⅛″ to 2½″.
5	1	Pipe wrench, 10″.
6	1	Pipe wrench, 18″.

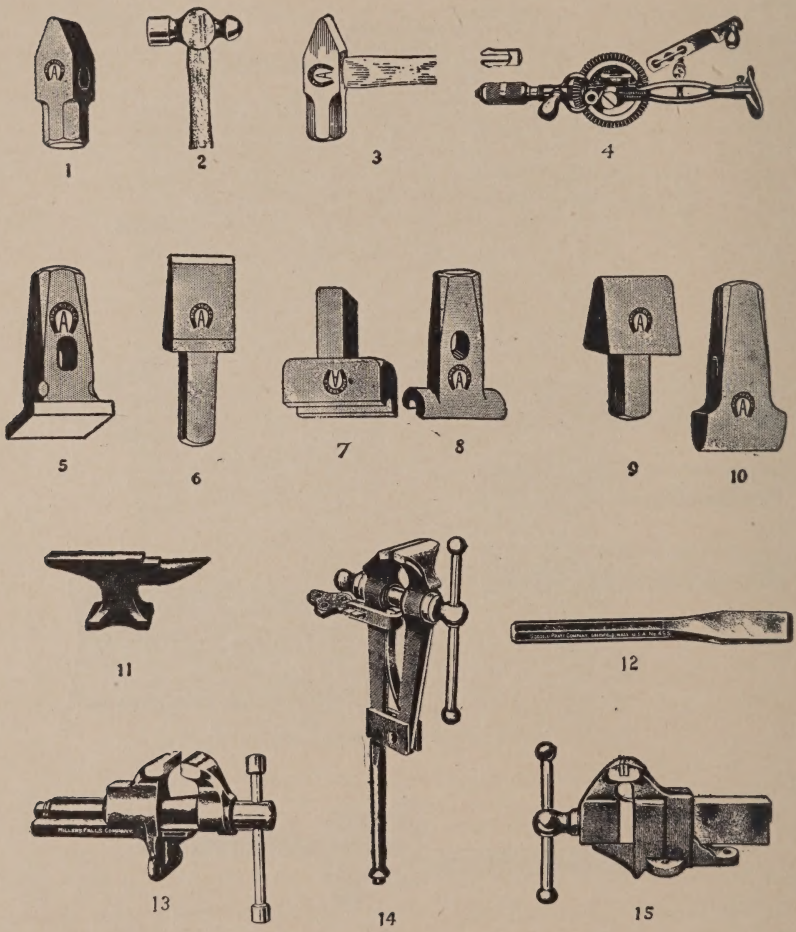


Fig. 18. Tools used for Farm Blacksmithing

1. Sledge. 2. Ball pene hammer. 3. Straight pene hammer. 4. Breast drill. 5. Square flatter. 6. Hardie. 7. Bottom swage. 8. Top swage. 9. Bottom fuller. 10. Top fuller. 11. Anvil. 12. Cold chisel. 13. Vise, oval slide type. 14. Blacksmith's vise. 15. Machinist's bench vise.

D. Tools used in farm blacksmithing.

Only about one tenth of the successful farmers in Pennsylvania have forges on their farms.[1] The ratio may vary somewhat among the

[1] F. Theodore Struck, *Farm Shop Work in Pennsylvania*. Special Bulletin No. 1, 1920. The Pennsylvania State College.

various states, but it is safe to conclude that they are less frequently used than they used to be. Better highways and the automobile make it possible to depend in many instances on the town blacksmith. However, there are farmers — perhaps about ten per cent of them — who will want to operate forges of their own. Therefore, the following list of tools is given:

List of tools for farm blacksmithing

Item	Quantity	Description
1	1	Cold chisel, ½″.
2	1	Hack saw, adjustable, 8″ to 12″ with 1 doz. 10″ blades.
3	1	Hammer, ball pene, 10 oz.
4	1	Punch, center, ⅜″.
5	1	Set of screw-plates, taper taps, dies and collets cutting ¼″–20, 5/16″–18, ⅜″–16, 7/16″–14, ½″–13. (The fraction represents diameter; the figure following it represents the number of U.S. Standard threads per inch.)
6	1	Monkey wrench, 8″ or 10″.

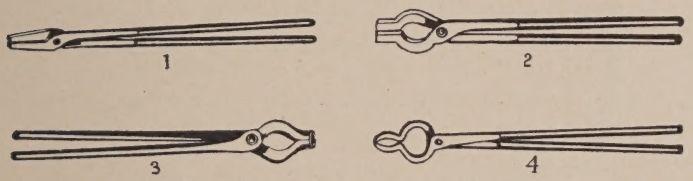


Fig. 19. Types of Tongs

1. Straight lip. 2. Gad. 3. Bolt (or round iron). 4. Pick-up.

Additional desirable equipment

Item	Quantity	Description
1	1	Anvil, 100 lbs.
2	1	Chisel, cold, 2 lbs.
3	1	Chisel, hot, 1¼ lbs.
4	1	Forge, portable with half-hood and with blower.
5	1	Hammer, ball pene, 1½ lb.
6	1	Hardie, ¾″ blade 1⅞″ (shank to fit hole in anvil).
7	1	Pair tongs, "V" notched jaws for ¼″ stock, 18″.
8	1	Pair tongs, bolt tongs, 18″.
9	1	Pair tongs, straight lip, 18″.
10	1	Pair tongs, general forging, flat jaws, 18″.

E. Tools used in soldering and babbitting.

A small percentage of farmers may wish to do soldering and babbitting on their farms. For this work the following list of tools is suggestive:

Item	Quantity	Description
1	1	Chisel, plugging ⅝″.
2	1	Gasolene torch.
3	1	Pair of snips, 3½″ cut.
4	2	Soldering coppers, weight 1 lb. each.
5	1	Ladle (for Babbitt metal) 3″, long handle.
6	1	Rosin container (brass).
7	1	Acid container (crockery or lead).
8	1	Half round file.

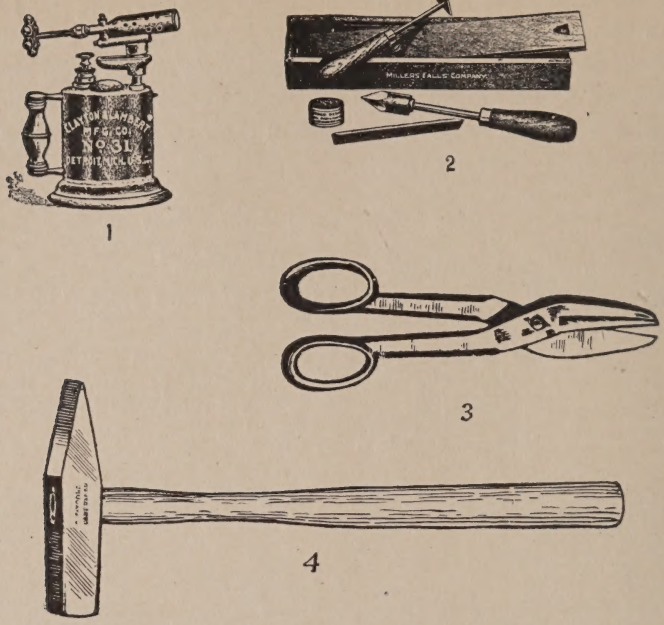


FIG. 20. TOOLS USED IN SHEET-METAL WORK

1. Blow torch. 2. Soldering set. 3. Snips. 4. Riveting hammer.

F. Tools used in harness and leather repair work.

ITEM	QUANTITY	DESCRIPTION
1	1	Awl, automatic sewing with straight and curved needles.
2	1	Awl, harness-maker's collar or drawing, 8″.
3	1	Awl haft.
4	1	Paper of needles, harness-maker's, assorted.
5	1	Rivet set No. 1 and No. 2.
6	1	Spring punch, revolving, 4 tubes.

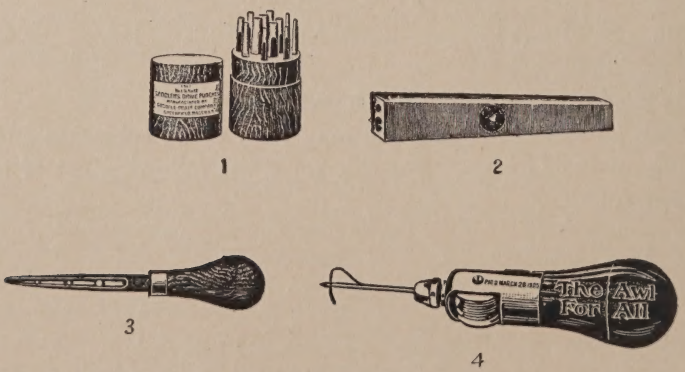


FIG. 21. TOOLS FOR WORKING LEATHER

1. Drive punches. 2. Rivet set and header. 3. Belt awl. 4. Sewing awl.

G. Tools used in painting.

1. *Paint brushes.* A paint brush is the only tool that is absolutely necessary to do a job of painting. It is usually desirable to have brushes of several sizes. The best brush for plain painting is a round brush about 1½″ or 2″ in diameter, having bristles four to six inches long. When new, tie a string or rag around the top to reduce the effective length of the bristles. Another type of brush that gives satisfaction for general work is an oval brush about 2½″ wide. Flat brushes from one to five inches in width are used a good deal. Paint can be spread rapidly with a brush four or five inches wide, but the paint is not likely to be rubbed on well as is the case with round or oval brushes.

   For painting window and door screens, sash, and narrow mouldings small round brushes with either convex ends or with chisel points are used.

2. *Care of paint brushes.* Paint brushes may be made to last for years on the farm if properly taken care of. The following points should be kept in mind:

   a. Brushes that are to be laid aside for some time should be thoroughly cleaned.

      Use kerosene, or turpentine, though kerosene is cheaper, for brushes used in oil paints, oil stains and varnish.

      If possible finish by rinsing in gasoline, or by washing in warm soapy water.

      Use denatured alcohol to clean brushes used in shellac, alcohol stain, or any preparation having an alcohol vehicle.

   b. If a brush has become more or less hard with paint it may be cleaned with most good varnish removers. Varnish removers are strong solvents used to remove paint and varnish for purposes of refinishing.

   c. To keep brushes for short intervals:

      A brush used in oil paint may be kept over night by wrapping it tightly in paper.

      A brush used in shellac, varnish, or varnish stain should be cleaned after use or stored properly.

   d. Store brushes in covered pails or jars containing linseed oil, turpentine or kerosene for brushes used in these vehicles, and substitute denatured alcohol for brushes used in alcohol vehicles.

   e. Hang brushes so that their tips do not touch the bottom of the pail or jar, as this would destroy the shape and effectiveness of brushes.

3. *Putty knife.* If a putty knife is not at hand one can be made by filing or grinding a square end on an old case-knife.

4. *Scraper.* A scraper may be made from an old saw blade or other piece of sheet-metal.
5. *Oily waste.* Rags or cotton waste soaked with oil, turpentine, japan, or alcohol should never be left lying around as spontaneous combustion may take place. Many a fire has been started that way.

REFERENCES

Dibble, Samuel Edward. *Elements of Plumbing.* McGraw-Hill Book Co., 1918.
Griffith, Ira S. *Essentials of Woodworking.* Manual Arts Press, 1908.
Noyes, Wm. *Handwork in Wood.* Manual Arts Press, 1910.
Roehl, L. M. *Harness Repair.* Manual Arts Press, 1920.
Struck, F. Theodore. *Farm Shop Work in Pennsylvania.* Special Bulletin No. 1. The Pennsylvania State College, State College, Pa., 1920.
Woods, Harry E., and Smith, James H. *Prevocational and Industrial Arts.* Atkinson, Mentzer & Co., 1919.

The following are representative firms from which tool catalogues may be secured. Many equally good firms are not listed here. For further information see Thomas's *Register of American Manufacturers* (4500 pages).

Greenfield Tap and Die Corporation. Catalogues No. 40 and No. 42. Greenfield, Mass., 1920.
Hammacher, Schlemmer & Co., tools. Catalogue No. 500. New York, 1920.
Henry Disston. General Catalogue. Philadelphia, 1918.
Millers Falls Co. Catalogue No. 37. Millers Falls, Mass., 1919.
Simonds Hardware Co. General Catalogue. Philadelphia, 1920.
Stanley Rule & Level Co., tools. Catalogue No. 120. New Britain, Conn., 1919.
Vaughan & Bushnell Manufacturing Co. General Catalogue. Chicago, Ill., 1920.

CHAPTER III

SHARPENING TOOLS

A GREAT deal of pleasure and satisfaction are derived through the use of tools that are in proper condition for the work for which they are intended. Aside from this pleasure it is good business to work with sharp edge tools, as time, human energy, and patience are conserved by using tools that are in good working condition.

A precaution that may well be observed by all people in sharpening tools consists in carefully examining all tools used to see just how the manufacturer has adjusted and sharpened them. The same slant or pitch that has been given them by the manufacturers should nearly always be maintained.

A. General principles.

There are certain fundamental principles to be observed in sharpening edge tools.

a. Turn the grindstone, emery, or carborundum wheel *toward* the edge to be ground instead of away from it.

Turning the stone toward the edge to be ground favors rapid, easy grinding, and reduces chances of having a rounded or a wire edge.

b. Time is usually saved by using stones of different degrees of fineness — one to "rough-off" the tool and the other to smooth off or whet the cutting edge.

c. If high-speed wheels, such as geared bench grinders, are used, be careful not to apply too much pressure on the tool as it may become heated to the extent of drawing the temper. This is evident when a bluish color appears at the edge of the tool where it is in contact with the revolving stone.

d. Always use protective goggles when using high-speed grinders.

B. Certain edge tools.

1. *Auger bits.* An auger-bit file is the best tool to use in sharpening auger bits. In the absence of an auger-bit file, the tip of a three-square (three-cornered) file used for hand saws can sometimes be used.

Before filing the auger bit, look at it carefully to see how and where to file it. Be sure not to file the nibs (Fig. 13) on the outer side. If they need sharpening, file them on the inside where they were sharpened by the manufacturer. If possible keep the nibs as long as when new.

If the cutting lips need sharpening, file them on the underside, considering the shank as the top end of the bit. In sharpening the cutting lips, as well as other parts of the auger bit, keep the same bevel or slant that it has when new. It may happen that the auger bit has been run on a nail and the cutting lips dulled. If an auger-bit file is not at hand, and other files are too large to file the lips on the under side, then the best thing to do is to file the lips on the upper side, making the slant meet the twist of the bit.

In case the lead-screw is stripped or otherwise injured, pass a three-square file over the original threads.

2. *Twist drills.* Since "an ounce of prevention is worth a pound of cure" it is well to use plenty of good lard-oil on twist drills when boring cast iron, steel, or other hard substances.

When the drill becomes dull it may be sharpened by using a good file — preferably a single-cut mill file — or by grinding.

The following points may be noted:

a. If the clearance of a drill is not sufficient, it will not cut. This means that the cutting edge should be the lowest edge on the drill, so that no part of the twist extends below the cutting edge as it revolves.

b. The cutting edges should be straight and at an angle of 59 degrees to the center line of the drill. If no drill gauge is at hand, grind or file so as to keep its original form as closely as possible.

In order to see if the clearance is sufficient, place the drill against the inside of the blade of a steel square. Turn the drill slowly and note the distance from the point of the drill to the end of the ground edge as shown by the reading on the tongue of the square.

3. *Screwdriver bits.* The side faces of screwdriver bits should be ground or filed perfectly flat. The end of the bit should be straight and blunt and thin enough to fit into the slots in the heads of the screws. The most common mistake in sharpening consists in giving the side faces a rounded shape and drawing the end of the bit to a sharp thin edge. This is unsatisfactory, as the thin edge tends to break or bend, and the curved surface tends to force the bit out of the slots in the head of screws when much pressure is applied.

4. *Chisels.* The angle at which chisels should be ground depends a little on the nature of the work they are to perform. For fine work the edge may be thinner than for heavy work including the cutting of knots. In general an angle of 20 degrees is good. In whetting, use about 22 to 25 degrees. In other words, whet only the cutting edge.

It is important that chisels be ground only from one side, and that the edge be square and straight.

In whetting, the wire edge may be removed by a few strokes with the chisel flat on the oilstone.

5. *Plane blades.* Plane blades are sharpened like chisels, with this exception: the extreme corners of plane blades are "rounded off" or ground about 1/32" lower than the main edge, which should be straight across. This slight rounding off or lowering of corners helps to prevent the plane from "streaking" the surface that is being planed. The streaking referred to consists in grooves cut below the surface that is desired by the corner or corners of a plane blade.

   A block plane bit is rounded or crowned very little, often not at all. Smooth plane bits should also have very little rounding of the corners. Jack planes and larger planes may be crowned a little more, but the amount of crowning given must be governed by the work that is to be done.

6. *Shears.* Pruning shears and other shears are ground from one side only. Follow the bevel put on the tool by the manufacturer. When the surface is ground it should be whetted to a smooth, sharp edge. Particular care needs to be exercised that shears are not ground on the flat sides that pass each other.

C. How to joint, set, and file hand saws.

The processes of jointing, setting, and filing saws go to make up what is technically called saw-fitting. Since these three operations are distinct they will be described under the separate headings mentioned.

1. *Saw-jointing.* The tool used is a saw-jointer such as is shown in Fig. 22. This figure shows a form of commercial jointer made largely of cast iron and two types of wooden, home-made saw-jointers that give satisfaction. In the absence of a saw-jointer a flat mill file may be passed over the saw.

   The purpose of the saw-jointer is to make the saw teeth of uniform length, so that the points will be in the same line. This line, by the way, is usually crowned somewhat in hand saws. This is done to make the saw work more freely. When a saw has been run on a nail, and when because of imperfect filing the teeth tend to vary from the slightly crowned line given a saw by the manufacturer, jointing is necessary to maintain the proper height and line of the teeth.

   The first step in fitting a saw consists in jointing it. Joint saws just before each time that they are filed. Place the saw in a saw clamp or vise such as is shown in Fig. 15. Keep the saw teeth far enough above the clamp to permit the jointer to

pass freely. Pass the jointer over the teeth lightly, taking off enough to line up the teeth properly. This usually requires only about two strokes, unless the teeth are very irregular in height.

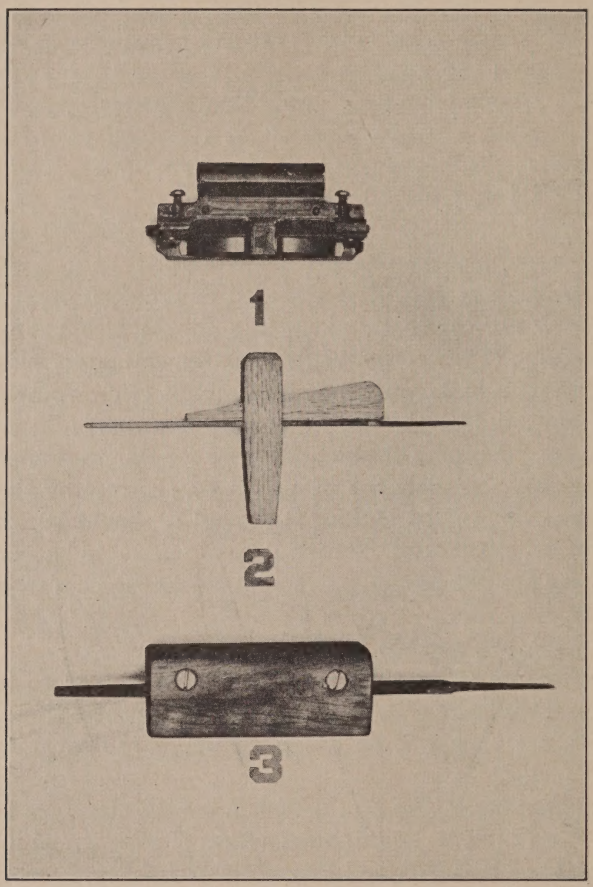


Fig. 22. Types of Saw-Jointers

In this latter case it may not be best to true up the teeth in one jointing and filing, but do it by means of two or three separate fittings.

It is important that the jointer, or the flat file if a jointer is not at hand, be passed over the saw squarely; that is, at right angles to the side of the saw. Unless this is done the saw will "run" or cut faster on the side having the longer teeth, thereby making it more difficult to saw to a line, especially on material two or more inches thick.

2. *Saw-setting.* After jointing the saw it should be set, provided it does not already have set enough.

The tool to use is a saw-set such as is illustrated in Fig. 15.

Remove the saw from the vise, hold it with the handle toward you, with the saw blade resting between your knees as you sit on a sawhorse, bench, or box, and with the saw-set in position approximately at right angles to the saw teeth, begin to set the saw from heel (the part near the handle) to toe (or the tip). Then reverse the saw, holding the tip toward you while the handle rests between your knees, and set every alternate tooth in the direction opposite to that given the first half of the teeth. The saw then will have half of its teeth set to the left, and the other half to the right as one looks along the cutting edge.

The process of setting consists in bending every alternate tooth outward by means of a plunger which bends the tooth over an anvil or small disk. In some saw-sets these anvils have faces bearing numbers that correspond to the number of points per inch on saws, so that it is easy to adjust the saw-set. Upon examination it will be found that there is always one less tooth per inch than there are points per inch of saw blade. Saws are marked according to the number of "points" they have per inch of cutting edge.

In general the set should be just wide enough to allow the saw to work freely. For green or wet lumber it must be more than for hard or dry lumber. About $\frac{1}{100}$" projection on each side is often sufficient, due to the fact that many hand saws are taper-ground. This means that the saw blade is ground thinner toward the top of the saw than where the teeth are. This may be observed by looking directly at the front end of the saw.

The depth to which the teeth are set is important. It should not be greater than half of the length of the tooth, as otherwise the teeth may be broken off, or the saw blade may be kinked. The greatest danger of setting the teeth too deep occurs at the extreme ends of the saw where the set can rest only partially on the blade.

The set should be as uniform as possible. Set the anvil of the saw-set for the number of points per inch that the saw has, as is often shown by the figure stamped near the teeth at the base of the saw, and press the plunger firmly against the teeth. Be sure not to set teeth over in opposite directions during successive settings. In other words, set the teeth always in the same direction originally given them — half of them to the left, the other half of them to the right as the eye looks along the row of teeth.

Several disadvantages grow out of having too much set in saws. If the teeth have too much set the saw will cut a wider kerf than it needs to. This means that more power is needed to push the saw, and more material is wasted by sawing than

there needs to be. The saw also tends to "chatter" or quiver, making it more difficult to split a fine line in sawing.

3. *Saw-filing.* (General information.)

a. *Tools used in saw-filing.* The only tools required for filing saws are three-cornered files of the proper kind, and a saw clamp to hold the saw. The proper files to use for various saws are given in Table 2.

TABLE 2. KINDS OF FILES TO USE FOR HAND SAW-FILING

KIND OF SAW	POINTS PER INCH	DESCRIPTION OF FILE TO USE
Cross-cut	3 to 4 inclusive	7″ Regular taper, 3 square file
"	4½ to 5½ "	6″ " " " " "
"	6 to 9 "	4½″ " " " " "
"	10 to 12 "	5½″ Slim " " " "
Rip	4 or less	6″ Regular " " " "
Rip	4½ to 6″ "	4½″ " " " " "

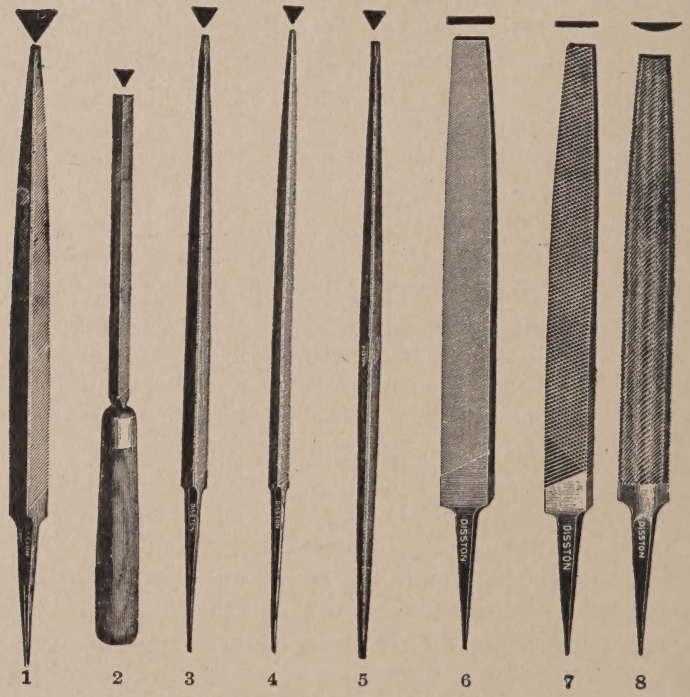


FIG. 23. SOME USEFUL FILES FOR THE FARMER

1. Regular taper saw file. 2. Hunt's chrome three-square. 3. Slim taper saw file. 4. Extra slim taper saw file. 5. Reversible taper saw file. 6. Mill file. 7. Flat wood file. 8. Cabinet file.

Various forms of cast-iron saw clamps are on the market. A good home-made clamp is shown in Fig. 219. A clamp may also be made by taking two stiff, straight boards about 28″ long which may be held in a vise and adjusted so as to serve as a saw clamp.

b. *Height of saw clamps.* Whether one sits down to do a job of saw-filing or stands up, the top of the clamp should be at a height so that it will come up to one's elbow joint. It is usually best to stand when filing, as one can work to a little better advantage that way.

Obtain the best light possible on the clamp, such as that of a north window.

c. *How to place the saw in the clamp.* Place the saw in the clamp with the heel of the saw to your left, and the tip to your right as you face the saw in the clamp. Let the teeth project above the jaws of the clamp just far enough to permit filing. The less the bottoms of the teeth project above the saw clamp, the less likely the saw is to chatter or screech when filed. Filing can be done more easily and more accurately when the saw blade is held low and firmly in the clamp or vise.

d. *How to hold the file.* The file should be firmly fastened in a good handle such as the one shown in Fig. 209. A corn cob or a piece of a buggy spoke is a poor substitute.

If you are right-handed, grasp the file handle firmly in the right hand letting the index finger rest upon the tang or base end of the file. The left hand is used to steady and guide the file, the tip of the file being held between the thumb and the index finger of the left hand. The left forearm is held in an approximately horizontal position.

File only on the forward stroke, lifting the file slightly each time on the return stroke rather than letting it drag. Dragging or running a file opposite to the way it is meant to cut tends to spoil the edges of the file, and should not be encouraged.

The handle end of the file is held a little lower than the tip-end in most saw-filing.

4. *Filing hand saws for cross-cutting.* Saw manufacturers do not agree in their recommendations as to whether one should begin at the heel of the saw and file toward the toe or whether one should begin at the tip of the saw and file toward the heel or handle end of the saw, and mechanics differ in their practice in this regard. It may be advisable for the amateur saw-fitter to stick to the same method of filing as used by the manufacturer. This is done by placing the file in the gullet or bottom of the tooth in such a way that the file will exactly fit the two adjoining teeth. The file will then have the correct position which, for general purpose cross-cut hand saws, is an angle of 45 degrees to the side of the saw. The front of the tooth may have an angle of 12 degrees from the vertical, and the back of the tooth an angle of 48 degrees from the vertical.

If one wishes to file hand saws for cross-cutting by working from the point of the saw toward the heel, the process is as follows:

a. With the saw clamped in position, and the file held as already explained, face the clamp, standing slightly to its left, with the tip of the saw nearest to you or at the left end of the

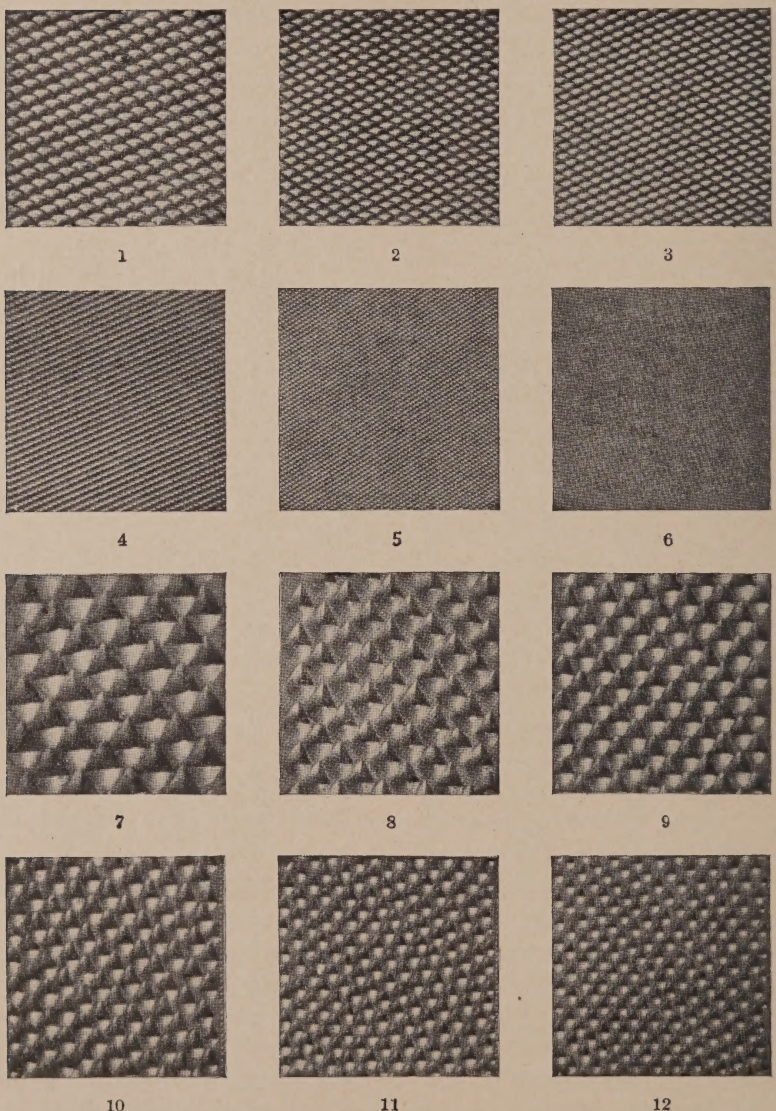


FIG. 24. SHOWING VARIOUS KINDS OF CUTS USED ON FILES

Nos. 1–6, "Double cut." 1. Rough. 2. Middle. 3. Bastard. 4. Second cut. 5. Smooth. 6. Dead smooth. Nos. 7–12, "Rasp cut." 7. Horse. 8. Rough. 9. Middle. 10. Bastard. 11. Second cut. 12. Smooth.

clamp. Place the file in the gullet of the first tooth that was filed from that same side. (The gullet will slope toward you and will line up with your file as you hold it at an angle of 45 degrees toward the handle.)

b. Proceed by filing every alternate tooth-space, touching the front of one tooth and the back of the adjoining one until that side of the saw is completed. The same angle and bevel being kept throughout that side.

c. Reverse the saw end for end and file this side also, placing the file in the alternate gullets not touched in going over the opposite side of the saw.

In filing remember that the teeth are all to come to the height to which they were jointed. The dull points seen at the ends of the teeth as one looks down upon them should be removed half from one side, and half from the other. Therefore, do not file the teeth to a point from one side of the saw, but reserve half of the job for the time when the saw is turned end for end and the teeth are filed from the other side.

If the teeth are not of uniform size, apply pressure on the file in such a way as to equalize the teeth as to size, and so as to have the angle and bevel of filing the same for each alternate tooth.

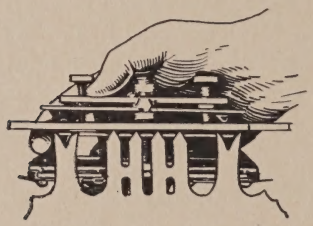
d. After the saw has been properly set and filed, the next operation consists in side-dressing it. By side-dressing is meant the process of removing the wire edge, and any excessive set that a saw may have. In order to side-dress the saw, lay it flat on a board or work bench in such a way as to give the saw blade a uniform bearing all along its cutting edge. Then pass a fine hard carborundum or other whetting stone over the teeth on each side of the saw, using a light touch, and a rotary motion. In this way the wire edge is removed. After a few strokes squirt some sperm oil on the saw and try it on a piece of scrap lumber. If the saw kerf is too wide, the set of the saw may be reduced by repeating the side-dressing. Side-dress the saw an equal amount on both sides.

5. *Bucksaws, pruning saws, and compass saws.* All of these saws differ in the angles and bevels used in filing, but the principles as explained for filing hand saws for cross-cutting apply in each case. Simply use the angle and bevel that is used by the manufacturer. This is best noted in the teeth that are used least in saws that have seen some service. If the saw is old and the teeth are in such poor condition that you do not feel equal to the task of putting them in good working order, either have some local carpenter or saw-fitter do the job or else send the saw back to the factory to have it retoothed.

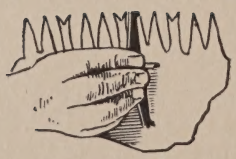
6. *Filing hand rip-saws.* A rip-saw can easily be distinguished from a cross-cut saw, not necessarily by the size of the teeth, though the latter tend to be larger in rip-saws than in cross-cut saws, but by the fact that rip-saws are filed square across at right angles to the side of the saw instead of at an angle of 45 degrees as is the case in hand cross-cut saws. The fronts of the teeth on rip-saws should be straight up and down or at an angle of 90 degrees to the line of the teeth, while the back of the teeth make an angle of 60 degrees with the front of the teeth.

Half of the teeth should be filed from each side, every alternate tooth being filed from the same side. This is to equalize the wire edge and bevel that may be given in filing.

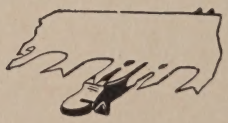
Hold the file with the tip slightly higher than the handle and file square across. By lowering the handle, a slight bevel may



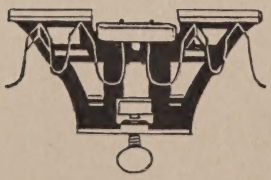
1



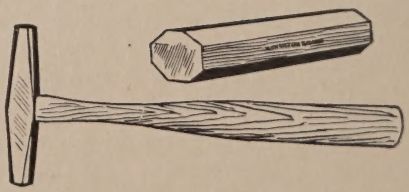
2



3



4



5

FIG. 25. TOOLS USED IN JOINTING, SETTING, AND FILING ONE AND TWO-MAN CROSS-CUT SAWS

1. Using a jointer. 2. Set gauge. 3. Setting Block. 4. Raker Gauge. 5. Swaging hammer and anvil.

be given to the top or points of the teeth. This bevel is considered desirable by some. Others file square across, and as level as possible.

Rip-saws are jointed, set, and side-dressed just like cross-cut saws.

D. How to joint, set, and file one and two-man cross-cut saws.

1. *Clamp or vise to use.* One-man or two-man cross-cut timber saws are held in clamps of various kinds. Out in the woods, away from bench and vise conveniences, the saw is placed between two boards which are crowned the same way that the saw is. These boards are held together by means of upright pegs that are driven into a plank. Holes are bored for these pegs.

   A work bench having a vise, preferably a blacksmith's, or a metal bench vise can be used to advantage. Boards can be clamped together by means of the vise in such a way that the saw is well supported for filing.
2. *Height of clamp.* The saw should be clamped at about elbow height from the floor. The best light is obtained by having the filer face a north window. If out of doors, the filer should select a shaded place, and face the north.
3. *Tools required.*
   1 mill file, 8″.
   1 combined jointer and raker gauge.
   1 setting hammer.
   1 setting block or anvil.
   1 set gauge.
4. *Directions.*
   a. Place a file in the jointer, and joint the teeth until the shortest cutting tooth is reached. Use the jointer lightly, and keep the file square to the saw blade. It is not necessary to joint the saw heavily before each filing. If a partially worn file is used in the jointer there will be less danger of jointing off too much of the teeth.
   b. If swaged rakers are used, the next step will consist in filing the rakers to sharp square edges without changing their length. The fork at the top should be ⅜″ to ½″ deep. With the swaging hammer next bend the tips of the rakers outward, and downward. For very hard and dry wood the rakers should be $\frac{1}{100}$″ shorter than the cutting teeth; for hard, green wood such as oak or chestnut $\frac{1}{64}$″, and for soft green wood such as pine, hemlock or Douglas fir $\frac{1}{32}$″.

   The best way to get the rakers exactly the right length is to use a raker-tooth gauge such as the one shown in Fig. 25.

The gauge is adjusted according to numbers that indicate the adjustment. The teeth can then simply be made to come flush with the top edge of the part of the gauge that fits around the raker tooth.

c. In filing, shape the teeth to their original form, and bevel the edges as required by the work to be done. Care should be exercised to see that the teeth are brought to sharp points at the length to which they were jointed. The cutting teeth should always be longer than the rakers; otherwise the saw will not cut. It is well for right-handed persons to file the right-hand side of teeth first. The bevel obtained helps to guide the eye in pointing up the other side.

d. Side-dress the saw, or remove the wire edges from the teeth by passing a hard whetstone along the sides of the teeth.

e. It is not necessary to set the saw at each filing, especially if the latter is taper-ground. In case the saw needs to be set, the process is as follows: A hammer and set block are used in preference to a spring set, such as is commonly used for hand saws. Lay the saw on some flat surface, such as a plank, and pass it over the set block in such a way that the point of the tooth projects ¼″ over the apex or corner of the set block. Strike the tooth over the apex of the set block, then test the tooth with the set gauge. If the blow did not give set enough, repeat it; if the set is too great, reduce it by placing the tooth on the flat part of the block, and strike a blow that will cause the tooth to straighten out.

Set every other tooth from one side, and then reverse the saw, setting the other teeth in the opposite direction as in the case of hand saws, so that half the cutting teeth are set outward to the left, and the other half outward to the right as the eye looks along the saw-tooth edge of the saw.

REFERENCES

Disston, Henry & Sons, Philadelphia. Free pamphlets as follows:
(a) *The Disston Saw, Tool, and File Book.* 1921.
(b) *The File in History.*
(c) *The Saw in History.*

Griffith, Ira S. *Woodwork for Secondary Schools.* 1916. Chapter II. The Manual Arts Press.

Millers Falls Company, Millers Falls, Mass. Free pamphlet: *Handbook for Mechanics.* 1916.

Morrill Company, Charles, 100 Lafayette Street, New York City. Free pamphlet: *How to Joint, Set, and File Saws.*

Noyes, William. *Handwork in Wood.* 1910. Chapter IV. The Manual Arts Press.

Simonds Manufacturing Company, Fitchburg, Mass. Free pamphlet: *Simonds Guide for Carpenters.*

CHAPTER IV

MATERIALS COMMONLY USED

A. Lumber.

The term "lumber" as ordinarily used includes all material sawed from logs which is used for structural purposes. Lumber is usually cut in lengths of even feet, for example in lengths of 10, 12, 14, 16, 18, and 20 feet. The length and width varies according to the characteristics of the tree from which it is cut and with the purpose it is to serve.

1. *Units of measurement and terms used.* All rough lumber is sold by the board foot. A board foot is equivalent to a board 1 inch thick, 1 foot wide, and 1 foot long. Lumber less than 1″ thick is sold by the square foot, face measure. Lattice and mouldings are sold by the lineal foot. Laths and shingles are sold by the thousand.

   Boards vary from ¼″ to 1¾″ in thickness. Lumber that is from 1¾″to 4″ thick is usually spoken of as planks in most parts of the United States.

2. *Common sizes of lumber.* Lumber that is surfaced or dressed measures less than nominal size as may be seen in the Table:

Rough Lumber Nominal Thickness	Dressed Lumber Net Thickness
5/8″	1/2″
3/4″	5/8″
1″	13/16″
1¼″	1–1/16″
1½″	1–5/16″
2″	1¾″
2½″	2¼″

   In addition to reduction in thickness there is a corresponding reduction in width of ⅛″ to ¼″ or even up to ½″ in case of wide material.

3. *Estimating quantities of lumber.* In estimating quantities of lumber allowance must be made for the amount lost in dressing and in matching.

   The following rules may be followed:

   For 3″ matched flooring or ceiling add ½ to the area to be covered.

   For 4″ matched flooring or ceiling add ⅓ to the area to be covered.

   For 6″ matched flooring or ceiling add ⅙ to the area to be covered.

For common sheathing add ⅛ to 1/10 to the area to be covered.

For lap-siding laid 4″ to the weather add ¼ to the area to be covered.

1000 shingles averaging 4″ wide (4 bundles) cover about 110 square feet with 4″ exposure.

100 laths (1 bundle) each ¼″ × 1½″ × 4′ cover about 150 sq.ft.

4. *Rule for finding board feet in lumber.* The following method is often used to figure the board feet in lumber:

Multiply the thickness and width in inches by the length in feet, and divide by 12.

Example: Find the board feet in a 2″ × 4″ × 12′.

$2 \times 4 \times 12 \div 12 = 8$ board feet.

TABLE 3. BOARD MEASURE

(For finding the board feet in lumber)

THICKNESS AND WIDTH IN INCHES	LENGTH, IN FEET, OF LUMBER														
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
2 × 4	3	4	5	7	8	9	11	12	13	15	16	17	19	20	21
2 × 6	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
2 × 8	5	8	11	13	16	19	21	24	27	29	32	35	37	40	43
2 × 10	7	10	13	17	20	23	27	30	33	37	40	43	47	50	53
2 × 12	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64
2 × 14	9	14	19	23	28	33	37	42	47	51	56	61	65	70	75
3 × 6	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
3 × 8	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64
3 × 10	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
3 × 12	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96
3 × 14	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112
4 × 4	5	8	11	13	16	19	21	24	27	29	32	35	37	40	43
4 × 6	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64
6 × 6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96
6 × 8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128
8 × 8	21	32	43	53	64	75	85	96	107	117	128	139	149	160	171
8 × 10	27	40	53	67	80	93	107	120	133	147	160	173	187	200	213
10 × 10	33	50	67	83	100	117	133	150	167	183	200	217	233	250	267
10 × 12	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320
12 × 12	48	72	96	120	144	168	192	216	240	264	288	312	336	360	384
12 × 14	56	84	112	140	168	196	224	252	280	308	336	364	392	420	448
14 × 14	65	98	131	163	196	229	261	294	327	359	392	425	457	490	523

Directions: To find the board feet in a given piece of lumber read across the table in the column containing the thickness and width of the piece, and down the column corresponding to its length. The result is the figure found where these two columns intersect. For example, let it be required to find the board feet in a piece 2″ × 10″ × 16′. The answer as given in the table is 27 board feet.

The board feet in pieces not listed here may be found indirectly. For example, if it is desired to find the board feet in a piece of plank 6″ × 8″ × 2′. Find the answer from the table for a piece 6″ × 8″ × 4″ and divide by two (since 2′ is half of 4′, and the latter was used because 2′ is not given in the table).

B. Materials used in cement and concrete work.

1. *Kinds of cements.* Cementing materials in general are classified as follows:

1. Common limes
2. Hydraulic limes
3. Natural cements
4. Slag cements
5. Portland cement

2. *Natural cement.* Natural cement, mortar, or concrete should never be allowed to freeze while setting; it should not be laid under water, nor exposed to it for a month after laying. Owing to the fact that natural cement does not set or harden readily, it is not well adapted for use in footings, piers, walls, etc., which need to hold up loads soon after construction.
3. *Portland cement.* The term "Portland" does not refer to any one locality in which this cement is made. Portland cement is manufactured in many parts of the United States and elsewhere. It is used much more widely in the United States than either natural or slag cement.

   Portland cement is usually to be preferred to any other cement because of its exceptional qualities. It hardens readily under water and in damp places. It sets quickly, can be made waterproof, and its compression strength is great. The latter varies with the quality of the cement and the kind and the proportion of the mixture used. A "rich" mixture of one part of cement, one part of sand, and one of granite rock may stand up under a load of 3300 lbs. per square inch, while a mixture of one part of cement, one of sand, and three of cinders may withstand only 400 lbs. per square inch.
4. *Special terms used.*
   a. *Aggregate.* The term "aggregate" refers to sand, gravel, stone, or cinders which are bound together by cement to form either mortar or concrete.
   b. *Bank-run gravel.* Is a term that is applied to unwashed gravel as it usually comes from the pit.
   c. *Mixture.* The various proportions of cement, sand, and gravel that go to make certain mixtures is indicated as follows: 1:3:5. The first figure used stands for cement, the second for sand, and the last for gravel, crushed stone, or cinders.
5. *Proportions recommended for certain kinds of work.*[1]
   A 1: 2: 3 mixture: for feeding floors, one-course floors and sidewalks, water troughs, milk-cooling vats.
   A 1: 2¼: 4 mixture: for silo walls, and building walls above foundations.
   A 1: 3: 5 mixture: for basement walls, foundations, mass footings, base of sidewalks, small engine foundations, windmill footings.
6. *For mortar.*
   1: 2½ mixture: for finish coat of exterior plaster and for fence posts.

[1] For detailed list see *How to Make and Use Concrete*, page 11. Portland Cement Association.

7. *Quantities of materials required.*

TABLE 4. QUANTITIES OF MATERIAL REQUIRED FOR VARIOUS MIXTURES OF MORTAR AND CONCRETE [1]

MIXTURE MATERIALS FOR ONE BAG BATCH				RESULTING VOLUME IN CUBIC FEET		QUANTITIES OF MATERIALS REQUIRED FOR ONE CUBIC YARD OF COMPACTED MORTAR OR CONCRETE			QUANTITIES OF MATERIALS REQUIRED FOR ONE CUBIC FOOT OF COMPACTED MORTAR OR CONCRETE		
	Cement in sacks	Sand cu. ft.	Pebbles or stone cu. ft.	Mortar	Concrete	Cement in sacks	Sand cu. ft.	Pebbles or stone cu. ft.	Cement in sacks	Sand cu. ft.	Pebbles or stone cu. ft.
1:1½....	1	1.5	.....	1.75	.....	15.5	23.2	.....	.57	.86	.....
1:2.....	1	2.0	.....	2.1	.....	12.8	25.6	.....	.47	.95	.....
1:2½....	1	2.5	.....	2.5	.....	11.0	27.5	.....	.41	1.02	.....
1:3.....	1	3.0	.....	2.8	.....	9.6	28.8	.....	.36	1.07	.....
1:1:1½..	1	1.0	1.5	.....	2.3	11.9	11.9	17.8	.44	.44	.66
1:2:3....	1	2.0	3.0	.....	3.9	7.0	14.0	21.0	.26	.52	.78
1:2:4....	1	2.0	4.0	.....	4.5	6.0	12.0	24.0	.22	.44	.89
1:2½:4..	1	2.5	4.0	.....	4.8	5.6	14.0	22.4	.21	.52	.83
1:2½:5..	1	2.5	5.0	.....	5.4	5.0	12.5	25.0	.19	.46	.92
1:3:6....	1	3.0	6.0	.....	6.4	4.2	12.6	25.2	.16	.47	.94

8. *Washing aggregates.* Bank-run gravel, and often creek and river gravel, should be screened and washed before use. Clean water should be used in mixing mortar and concrete. Soil in mortar or concrete reduces its strength by affecting the binding power of the cement.

9. *Hand-mixing concrete.* Before mixing make sure that everything is ready so that the concrete can be poured or otherwise used as soon as it is mixed. The mixture must be used within twenty or thirty minutes after the water has been added. The following steps should be followed in mixing concrete:

   a. Spread a uniform layer of clean sand on the mixing platform which should be water-tight.

   b. Spread the cement over the sand and mix thoroughly by shoveling. The material should be shoveled over at least twice, or until a uniform color is secured.

   c. Add the screened gravel, crushed rock, or cinders, and shovel over at least twice in order to secure a uniform mixture.

   d. Add water slowly from a sprinkler or with a hose, and mix thoroughly until the concrete becomes wet enough so that it tends to flatten out when piled in a heap. The amount of water to be used varies with the nature of the work, but never have it so wet as to become "soupy." Too much water in the mixture weakens it.

C. Materials used in pipe-fitting.

1. *Kinds of pipe.* Various kinds of pipe are used for cold water supply, such as wrought iron, steel, lead, brass, and tin-lined

[1] From *How to Make and Use Concrete.* Portland Cement Association. (Based on tables in *Concrete, Plain and Reinforced,* by Taylor and Thompson.)

brass pipe. Black iron or steel pipe rusts more quickly inside and outside than does galvanized pipe. Galvanized pipe and fittings are superior to black iron and should be used almost exclusively for water-pipe in the home or on the farmstead. The coating of zinc that such pipe has inside and outside tends

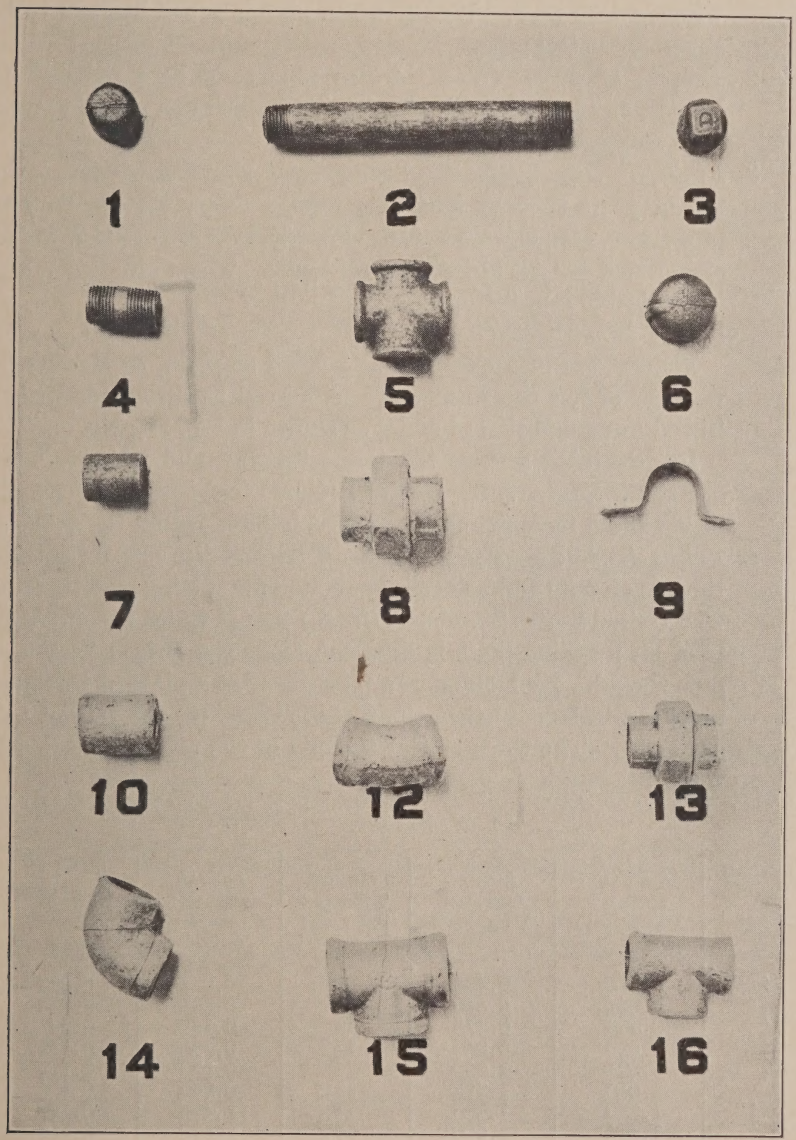


FIG. 26. STANDARD PIPE FITTINGS

1. Pipe cap. 2. Long nipple. 3. Pug. 4. Short nipple. 5. Cross. 6. Cap ¾". 7. Coupling ½". 8. ¾" nut coupling. 9. Strap. 10. Coupling ¾". 12. 45 degree elbow. 13. ½" nut coupling. 14. 90 degree elbow. 15. Tee, ¾". 16. Tee, ½".

to fill up tiny blow-holes and cracks as well as acting as a preventive to rust.

Steel pipe is manufactured more cheaply than wrought-iron pipe. With good quality adjustable dies threads may be cut on steel pipe somewhat more slowly, but as good as those on wrought-iron pipe. Wrought-iron pipe is generally held to be superior to steel pipe.

2. *Lengths of pipe.* Wrought-iron pipe may be purchased in lengths of 16 to 20 feet. Pipe mills furnish one coupling with each length of pipe.
3. *Fittings.* Pipe-fitting has been greatly simplified through the use of parts such as bushings, caps, crosses, elbows, flanges, plugs, tees, etc., called fittings. Fittings that are used for water, steam, and gas are of two general kinds. These are:
   a. Malleable iron fittings.
   b. Cast-iron fittings.

   Fittings are also classified as beaded or plain, depending on whether or not the fittings are reinforced at their ends with a "bead" or small ring of metal as shown in Fig. 26, No. 5.

   In describing fittings the terms "male" and "female" are sometimes used. A female fitting is one that is threaded on the inside and a male fitting is one that is threaded on the outside.
4. *Briggs standard taper pipe thread.* Taps and dies used for cutting threads on nuts and bolts are not suited for cutting pipe threads. The United States Standard (U.S.S.) thread which is commonly used on machine bolts is different from the Briggs Standard pipe thread. By looking at a pipe-die or at a piece of threaded pipe, it will be seen that the threads taper (at the rate of $\frac{1}{16}$" per inch). The threads near the end of the pipe are perfect V

TABLE 5. STANDARD DIMENSIONS OF WROUGHT IRON, WELDED STEAM, GAS, AND WATER PIPE

NOMINAL INSIDE DIAMETER INCHES	ACTUAL INSIDE DIAMETER	ACTUAL OUTSIDE DIAMETER	NO. OF THREADS PER INCH	ACTUAL INTERNAL AREA	THICKNESS OF METAL
$\frac{1}{8}$	0.270	0.405	27	0.057	0.068
$\frac{1}{4}$	0.364	0.540	18	0.104	0.088
$\frac{3}{8}$	0.493	0.675	18	0.153	0.09
$\frac{1}{2}$	0.623	0.840	14	0.305	0.109
$\frac{3}{4}$	0.824	1.050	14	0.533	0.113
1	1.048	1.315	$11\frac{1}{2}$	0.863	0.134
$1\frac{1}{4}$	1.380	1.660	$11\frac{1}{2}$	1.475	0.140
$1\frac{1}{2}$	1.611	1.900	$11\frac{1}{2}$	2.038	0.145
2	2.067	2.375	$11\frac{1}{2}$	3.356	0.154
3	3.067	3.500	8	7.388	0.217
4	4.026	4.500	8	12.73	0.237
6	6.065	6.625	8	28.89	0.280
8	7.982	8.625	8	50.04	0.322

threads, while the last four threads have flat tops and bottoms. This is done in order to assure an air and water-tight fit.

5. *Right and left-hand threads.* The standard thread for pipe is a right-hand thread. Left-hand threads may be cut with taps and dies and may also be purchased.
6. *Pipe sizes.* Pipe used for water, steam, and gas is made in sizes from ⅛″ diameter to large diameters. The inside diameter is used to describe the size of pipe. By a 1″ pipe is meant one having an inside diameter of 1″.

   Table 5 gives the diameter and the number of threads per inch for pipes from ⅛″ to 8″ in diameter.
7. *Lengths of threads.* In order to give an idea of how long threads should be cut on pipe, Table 6 is given:

TABLE 6. LENGTH OF THREAD ON PIPE REQUIRED TO MAKE A TIGHT JOINT

SIZE OF PIPE	LENGTH OF THREAD
⅛″	¼″
¼″	3/8″
3/8″	3/8″
½″	½″
¾″	½″
1″	9/16″
1¼″	5/8″
1½″	5/8″
2″	11/16″

It is common trade practice among plumbers to thread to such a length as will leave two full threads after the fitting has been tightened up.

8. *Drilling for pipe connections.* In order that a tight fit may readily be secured when drilling holes which are to be tapped out or threaded for pipe connections, it is necessary to use the proper size of drill. Table 7 shows the sizes of drills that should be used for given diameters of pipe, and the number of threads per inch that correspond.

TABLE 7. SIZE OF DRILL TO BE USED IN DRILLING FOR PIPE CONNECTIONS

SIZE OF PIPE (NOMINAL INSIDE DIAMETER)	SIZE OF DRILL	NUMBER OF THREADS
⅛″	21/64″	27
¼″	29/64″	18
3/8″	19/32″	18
½″	23/32″	14
¾″	15/16″	14
1″	1 3/16″	11½
1¼″	1 15/16″	11½
1½″	1 23/32″	11½
2″	2 3/16″	8
2½″ to 10″		8

9. *Compounds used in pipe-fitting.*

   a. *Pipe compound.* The term "pipe compound" is used for

material that is applied on pipe threads to make them water or air-tight, and to keep the threads from rusting so that the connection can be opened easily in case of necessity. Pipe compound may be purchased or white or red lead may be used. In the absence of these, thick paint will serve the purpose. Care should be taken not to apply too much compound, lead, or paint, as it may reduce the effective diameter of the pipe by collecting and hardening in the pipe.

b. *Lubricating oil.* The best grade of lard oil should be used freely on taps and dies when cutting threads, especially if steel pipe is used. Lard oil is made by mixing equal parts of melted lard and cotton-seed oil.

c. *Cementing compound.* Cementing compound or oxidizing paste is made of the following materials:

1 part, by weight, salammoniac.
2 parts, by weight, flowers of sulphur.
80 parts, by weight, fine cast-iron filings.

The materials should be mixed into a paste with water, and should be kept in a glass jar. The compound is applied at the time of "making up" the parts. Through oxidation it causes the fittings to rust together in such a way as to produce a bond that can usually not be broken without destroying the fittings.

D. Materials used in farm blacksmithing.

The materials most commonly used in farm blacksmithing are wrought iron, Norway iron, mild steel, and tool steel. A good deal of the work done is of the simpler sort, such as cold and hot bending, drilling, sharpening, shaping, and some welding.

Because of the various uses to which different kinds of iron and steel are put, and because some knowledge of the special characteristics of these materials are necessary, they are given herewith.

1. *Wrought iron.* Wrought iron has a fibrous structure mainly because of slag seams that are introduced during the process of manufacture. It is light gray in color, approaching a silvery white. Wrought iron may be bent, twisted, or hammered out while cold. By working it cold the metal becomes more brittle. Wrought iron of good quality is much easier to weld than steel because the slag in the former acts as a flux and permits it to be heated through a greater range of temperature than steel.

Various qualities of wrought iron are in the market. If certain impurities, such as sulphur and phosphorus, are present, they affect the ease with which the metal may be worked.

"Hot short" iron — that is, iron which is brittle when hot — usually contains sulphur. Such iron is welded with difficulty.

"Cold short" iron, or iron that is brittle when cold, usually contains phosphorus. It is welded more easily than hot short iron.

"Short" iron contains silicon or sand. This makes the iron harder and more brittle than it should be.

2. *Norway iron.* The purest soft iron on the market comes from Norway and Sweden. Norway iron is a much better grade of iron than common wrought iron. Horseshoe nails and rivets are made from it. It will stand a great deal of cold bending without injury and rusts less quickly than wrought iron. It is recommended for use by farmers because good results can easily be obtained through its use.
3. *Mild steel.* The difference in hardness in iron and steel is produced largely by carbon. Common wrought iron contains about .04 per cent of carbon. Mild steel contains from .05 to .5 per cent of carbon. Steel is stronger than wrought iron and is also cheaper because a different process of manufacture is used. In general an increase in carbon content also increases the hardening quality of steel, but it makes it more difficult to weld.

   Mild steel is sometimes sold as machinery steel, and as structural steel. A good way to describe the hardness of steel is by the carbon content.
4. *Tool steel.* Tool steel is also known as high-carbon steel. It contains from .5 to 2 per cent of carbon. Other substances, such as chromium, nickel, manganese, and tungsten, may be added in small percentages to give tool steel certain qualities. For example, tungsten steel containing from 1 to 3 per cent of tungsten is valued highly for cutting edge tools.

   Steel cannot be successfully forged at a dull red heat. It should be worked at a "cherry" red heat. Tool steel should not be "upset" any more than is necessary, as the crystalline structure, and therefore the quality of the steel, is affected thereby.
5. *Cast iron.* Cast iron cannot be welded in the common blacksmith's forge. If a break occurs, it may be repaired by reinforcing it with iron or steel fastened with bolts or rivets, or the casting may be brazed.
6. *Coal.* Hard (anthracite) coal is not suited for forge work because it burns without forming coke. Much of the ordinary soft coal likewise is not suited for forge work because of the presence of sulphur or phosphorus. Soft (bituminous) coal containing no sulphur or phosphorus is satisfactory and is most widely used. It may be purchased from dealers under the name of "blacksmith's" coal.

   In some places small-sized coke is available, and is used successfully for forge work.

7. *Fluxes and welding compounds.* By the term "flux" as used in blacksmithing is meant a substance which tends to keep impurities, such as sulphur fumes, away from the metal protected by the flux, and which tends to keep iron or steel from burning.

When iron or steel is heated, an oxide forms on the surface. If flux is sprinkled on the metal when it has reached a yellow heat, the flux melts the oxide formed and forms a sticky air-tight covering which prevents further oxidation. Fluxes do not act as cements, but prevent oxidation and make it possible to weld at a lower temperature.

It is not necessary to use a flux for welding wrought iron. If the iron is thin, pure sand may be used as a flux. Borax may also be used with success.

When welding steel, a flux such as powdered borax or sand should be used.

Many welding compounds may be purchased. Nearly all of them contain borax.

E. Materials used in soldering and babbitting.

Sheet-metal work or tin-smithing as it applies to the farm is largely a case of doing repair work. The principal tool involved is the soldering copper.

1. *Solder.* Ordinary soft solder is an alloy of lead and tin. The proportions vary according to the purpose for which it is intended. Wire solder — that is, solder sold in the form of wire ⅛″ in diameter, and used by electricians — has a lower melting point and different composition from "half-and-half" solder used by sheet-metal workers and plumbers.

The term "half and half" means that the solder is supposed to contain 50 per cent lead and 50 per cent tin, but not all "half and half" is true to name, therefore certain dealers sell "market half and half" and "strictly half and half." It is advisable to use high-grade solder. The more tin the solder contains up to 50 per cent, the better it is.

2. *Fluxes.* Fluxes in soldering serve much the same purpose as fluxes in welding. They tend to clean the metal, keep it from oxidizing, and reduce the temperature of fusing.

The kind of flux to use depends upon the sheet metal to be soldered.

Dibble, in *Elements of Plumbing*, page 12, gives the following:

Flux	How applied	Used on
Rosin	Sprinkled on	Lead, tin, brass
Tallow	Melted	Lead, brass
Muriatic acid (reduced)	With swab	Copper, galvanized iron and brass
Muriatic acid (raw)	With swab	Dirty galvanized iron

Various soldering pastes, salts, and powders are sold under trade names.

3. *Description of materials used for fluxes.*
   a. *Muriatic acid.* Commercial muriatic or hydrochloric acid when undiluted is spoken of as "raw" acid by sheet-metal workers.

      Reduced or "cooked" muriatic acid is made by slowly adding small pieces of scrap zinc to the acid. This is best done in the open air so that the fumes may not be inhaled. When chemical action stops, the acid is "reduced." It is well to keep a little zinc in the reduced acid to make certain that the acid is at all times reduced.
   b. *Tallow.* Ordinary tallow will serve the purpose of a tallow flux. Mutton tallow is better than paraffin candle.
   c. The rosin used for flux may be bought in bulk. Only a small quantity is needed. It can be pulverized readily by crushing. Keep it in a shaker or container.
4. *Tin plate.* The quality of tin plates depends largely upon the quality and thickness of the steel used in the base plates, and in the thickness of the tin coating.

   Tin plate or sheet tin, as it is sometimes called, is made in a variety of sizes and thickness. The sizes vary from 10″ × 14″ to 26″ × 26″.
5. *Sheet iron and steel.* Sheet mills roll iron and steel to U.S. standard gauge unless otherwise ordered. A few of the forty or more gauges made are given in Table 8 with their fractional equivalents and weight per square foot in order to serve as a guide in ordering sheet iron and steel.

TABLE 8. SHEET IRON AND STEEL

No. of Gauge (U.S. Standard)	Thickness in Inches		Weight in Lbs. per Sq. Ft.	
	Fractions	Decimals	Iron	Steel
0000000	1/2	.5	20.	20.4
3	1/4	.25	10.	10.2
11	1/8	.125	5.	5.1
16	1/16	.0625	2.5	2.55
22	1/32	.03125	1.25	1.275
28	1/64	.015625	.625	.6375
34	11/128	.008593	.34375	.3506
38	1/160	.00625	.25	.255

6. *Babbitt metal.* Babbitt metal like many other products is sold in poor as well as in good qualities. Some Babbitt metal is less shrinkable and has a lower coefficient of friction than others. High-grade Babbitt should be used for repairing bearings in engines, motors, and other high-speed or heavy duty machines.

F. Materials used in harness and leather repair work.

1. *Care of harness.* In order that harness may last as long as possible it is advisable to observe certain precautions.
   a. Clean the harness whenever it gets dirty.
   b. Use water to wash off dirt or mud, but do not let leather soak in water.
   c. Never use hot water on leather.
   d. After washing, dry the leather slowly in the shade — not in the sun or near a stove.
   e. Keep it well oiled; oil it at least twice a month when in use.
   f. If possible adjust buckles so that they will not wear in the same hole all of the time. This will help retard rotting and wear.
2. *Harness oil.* Use neat's-foot oil. If lamp-black is available, it may be stirred into the oil until the latter has a glossy appearance.
3. *Leather.* Oak-tanned leather, other things being equal, is better than leather tanned with hemlock bark. In using leather for belting, use the hair or smooth side against the drive wheel or pulley.
4. *Belt dressing.* Belt dressings of many kinds are on the market. They are intended to prevent belts from slipping, and to act as preservatives.
5. *Belt lacing.* The following are some of the forms of belt laces that are in use:
   a. Cut rawhide lace, ¼″ to ¾″ wide.
   b. Cut tanned lace, ¼″ to ¾″ wide.
   c. Metallic belt lacing (composition wire).

Thickness of Belt	Width of Belt	Size of Metallic Lace required
Single	2½″ and under	No. 0
Single	3″ to 5″	No. 1
Single	6″ to 12″	No. 2
Double	6″ and under	No. 2
Double	6″ and over	No. 3

   d. Copper rivets and burrs.
   e. Patent belt hooks.
   f. Patent plate belt fasteners.
6. *Flax thread.* Flax thread is used in leather repair work of various kinds. A number of strands, usually from three to six, are twisted together and waxed. Both the thread and the wax may be obtained from a local shoemaker or harnessmaker.

G. Paints, varnishes, and stains.

1. *Composition of paint.* The composition of paint varies somewhat according to the use to which it is to be put. Paint

made for exterior or "outside" work should contain pure linseed oil, pure white lead, coloring pigments, and not over 5 to 10 per cent "drier." Paint made for "inside" work, especially where a "flat" finish is desired, should contain considerable turpentine.

In general all ready-mixed paints should be used according to directions, and should not have oil, turpentine, or "drier" added unless this is specified.

2. *Linseed oil.* Linseed oil is made by crushing flax seed. Raw linseed oil is the natural flax-seed oil. Boiled linseed oil is made by adding "drier" to raw linseed oil.

   Fish oil and other oils are sometimes used in cheap paints instead of linseed oil. Raw linseed oil dries in about a week while boiled linseed oil dries in from twelve to twenty-four hours under ordinary weather conditions.

   The liquid part of paint, such as the linseed oil and turpentine, is called the "vehicle," for it "carries" the finely pulverized pigments and permits them to be spread uniformly throughout the paint.

3. *Drier or Japan.* The term "drier" or "Japan" is applied to a compound of lead or of manganese which acts as a drying agent by taking oxygen from the air and making it available for the paint.

4. *Turpentine.* Turpentine is used in paint to make it flow more freely, to hasten its drying, and to produce a "flat" or dull finish, as distinguished from the glossy finish produced by the use of linseed oil.

   Turpentine is a colorless liquid that is quite volatile and highly inflammable. It should be used sparingly in "outside" paint, as it lessens its durability.

5. *White lead.* The most essential pigment in paint is white lead. It acts as a binder in paint and adds to the durability of the latter. White lead weighs 20 to 22 lbs. per gallon. Because of its high price chalk and other substitutes are found in some cheap paints instead of white lead.

6. *Ready-mixed paints.* Unless one has a thorough knowledge of paint, it will be found better to use ready-mixed paints of reputable brands. The machine-mixed paints are more thoroughly blended than are hand-mixed paints; they are scientifically proportioned for certain kinds of work, such as metal paint, stove enamel, and exterior work, and the colors are uniform. This is important when repairs need to be made, or when other objects, such as flower boxes, are desired to match certain colors used for the farm home, the barn, or other buildings.

The best quality paints are the cheapest in the end.

7. *Putty.* Ordinary putty is made by mixing whiting (ground chalk or limestone) with boiled linseed oil. Keep putty in an air-tight tin or glass container. If it gets too hard to spread easily, add a little boiled linseed oil, or a very small amount (not over 5 per cent) of cotton-seed oil.

   Ordinary putty may be improved by adding about ten per cent white lead. This causes the putty to harden more quickly and to become harder.

   If putty is too soft, add whiting. In the absence of whiting, use flour. Rye flour is best.

   Putty may need to be warmed up in cold weather. Place the container in warm water, but do not put warm water directly on the putty.

8. *To remove putty.* If putty is hard to remove, apply kerosene. This will dissolve or "cut" the oil in the putty in a few hours sufficiently to soften it.

9. *Substitute for putty.* A cheap but effective substitute for putty which is good for filling cracks and joints in floors and other woodwork is made by soaking newspapers in a paste made by boiling a pound of flour in three quarts of water. A teaspoonful of powdered alum is stirred into this mixture. Newspapers are then soaked in the paste until it is about as thick as ordinary putty. Force this mixture into the cracks with a putty knife or an old case knife. The mixture will harden as it dries and may be stained or painted to match the woodwork.

10. *Estimating the amount of paint required.* The number of square feet of surface that can be covered with a gallon of paint depends upon the following factors:

    a. Kind and condition of the surface to be painted.
    b. Quality of the paint.
    c. Method of application.

    It may be estimated that one gallon of paint will cover from 250 to 400 square feet on first-coat work, and 350 to 500 square feet on second-coat work.

11. *Varnish.* Varnish is made from certain resinous gums found mostly in the warm countries such as Africa, the Philippine Islands, and Brazil. These gums are dissolved in linseed oil and thinned with turpentine. The best varnish is made from gum copal; the poorest from gum resin. Cheap varnishes often contain much resin. They do not withstand either heat or water as well as the better grades of varnish.

    Spar varnish is a waterproof varnish that is used where surfaces are exposed to sun or rain, as outside doors, railings, sash, and blinds, or for kitchen or bathroom floors.

Floor varnish is specially prepared for use on floors. A good floor varnish is elastic and waterproof.

Rubbing varnish is varnish that will stand "rubbing down" well. It is used for furniture where a hand-rubbed semi-glossy surface is desired.

12. *Shellac.* Shellac differs from varnish (oleo-resinous varnish) in that shellac is dissolved in alcohol instead of oil. Shellac and varnish should not be mixed.

Shellac has the following advantages: it dries very quickly, it is transparent — especially when bleached; and it can be finished in several different ways.

Its disadvantages are: Water will discolor it, cypress may make it cloudy, and it raises the grain of lumber.

Shellac is naturally of an orange-yellow color. Orange shellac is bleached with chlorine to white shellac. White shellac is more transparent than varnish. It deteriorates with age.

Shellac is good for a first coat under varnish used on interior work, and makes a good finish if several coats are applied.

Shellac is thinned out with denatured alcohol. Always keep it in an air-tight glass or earthen vessel when used occasionally. If exposed to air in tin containers, shellac will darken rapidly.

13. *Stains.*

a. *Purpose of staining.* Stains are widely used to emphasize the grain of wood. This is brought about by the fact that the "soft" grain absorbs more than does the "hard" grain or annular rings. Stains are also used to imitate some other wood, as, for example, mahogany; but this practice is not to be commended so highly as is the one in which it is used to enhance the natural beauty of wood.

Another use is that of giving color when desired, as in designs worked out in woods of different colors. Still another use for stains is found in giving the appearance of age to wood, as in the case of furniture, interior trim, and exterior of homes.

b. *Kinds of stains.* Stains are grouped into classes according to the nature of the liquids used in them. These classes are as follows:

Oil stains, spirit stains, acid stains and water stains.

(1) *Oil stains.* Oil stains are easy to apply. They do not penetrate deeply, and they darken somewhat with age. They are the best for soft wood such as white pine.

(2) *Spirit stains.* Spirit stains are more penetrating than oil stains. They are harder to apply, as the spirits in them are quite volatile and brush-laps are apt to show. Shellac should not be used directly over spirit stains.

(3) *Acid stains.* Acid stains are not recommended for use on the farm. As a rule acid stains are injurious to the wood upon which they are used.

(4) *Water stains.* Water stains are cheap, penetrating, and clear, but they fade unless "fixed" with a mordant, and they raise the grain of the wood on which they are applied. They are often used in factories where entire articles are dropped in vats of water stain, but are not so well adapted to occasional use on the farm.

14. *Fillers.* There are two kinds of fillers — liquid fillers and paste fillers.

Good paste filler is composed of silex or ground quartz and linseed oil. Silex does not expand or contract much in changing temperatures, and is therefore desirable as a base for fillers.

Paste fillers should be used in open-grain woods such as ash, chestnut, hickory, oak, and walnut. Use a stiff brush in applying paste filler. Brush the filler well into the grain, rub off the surplus, and allow the filler to dry. Then sand-paper before applying surface coats of varnish or shellac.

If a paste filler is to be used on any wood that is to be stained a light color, pour off the oil from the filler and substitute turpentine.

Liquid fillers are used for close-grained woods, such as basswood, birch, Douglas fir, cypress, maple, and pine. Shellac — either orange or white — will be found an excellent substitute for liquid filler in most cases. The shellac may be thinned out about 25 per cent with denatured alcohol.

Fillers made of cornstarch, turpentine, and linseed oil are not so good as those containing ground quartz or silicon.

15. *Wax.* Finishing wax is used in liquid and in paste form. Liquid wax is recommended for furniture and paste wax for floors.

Floor and other finishing waxes are made of vegetable wax which is dissolved in turpentine or other volatile liquids. Paste wax may be applied by placing the wax in several thicknesses of cheese cloth and rubbing it on the surface to be treated. It should then be allowed to dry — that is, the volatile liquids should be given a chance to evaporate for an hour and the surface may then be polished by rubbing with a cloth or stiff brush. Weighted brushes are sold for waxing floors. Several coats need to be applied to get a good effect. If a good wax finish has been worked up, it can be maintained with little effort.

A wax finish on floors is objected to by some persons because it becomes rather slippery. On the other hand, many persons

are very fond of the artistic semi-gloss produced by a wax finish. Such a finish can also be produced by "rubbing down" varnish with pumice stone and oil.

H. Sand-paper.

Sand-paper is made by coating a strong paper with sharp, clean sand or with garnet crystals of approximately uniform size. The sand or garnet is held to the paper by means of glue. The term "flint-paper" is given to paper coated with sand, while the term "garnet-paper" is used for paper covered with garnet crystals. The latter is best for use on hardwood. Both forms of paper are sold in sheets 9″ × 11″ and in rolls. The finest grade made, as regards size of cutting grains, is No. 000, the coarsest No. 3. For general use on the farm Nos. 1 and 1½ are good.

1. *Method of use.* In sand-papering flat surfaces it is advisable to use a sand-paper block about 1″ × 4″ × 10″. The most satisfactory sand-paper blocks are made of cork, but a good substitute can be made by padding an ordinary wood block with three or four thicknesses of worn-out sand-paper. The idea is to produce a soft cushion which will make it easy to apply uniform pressure. This tends to keep pitch, if any is present, from "balling up" on the sand-paper.

   Occasionally sand-paper should be used over the finger tips without a block. This may be the case when a deep bruise in wood needs to be smoothed. In sand-papering curved surfaces, such as moldings, use a block made to fit the curves.
2. *How to tear sand-paper.* Fold the paper sanded side against sanded side, press along the crease on the unsanded side with any hard object, such as a piece of wood, and it will be found an easy matter to tear the paper by hand without the use of any straight edge, along the line where it was folded.
3. *Emery cloth.* Emery cloth is made like sand-paper, but cloth is used instead of paper, and pulverized emery is used instead of sand. It is used largely for smoothing, fitting, polishing, and cleaning metal. Emery cloth wears better when used on iron or steel than does flint or garnet paper.
4. *Use for worn sand-paper and emery cloth.* Sand-paper that is worn somewhat may be used to good advantage in rubbing down shellac or varnish, between coats. If nothing but coarse sand-paper is at hand and a finer grade is desired, the need may be met by use of partly worn paper of the grade at hand, or by rubbing two pieces of coarse sand-paper together, sand against sand, until the coarse particles are cut down.

   Old sand-paper and especially old emery cloth is good for cleaning rusty tools and machinery. Squirt some kerosene on

the rusted surface and rub with old sand-paper or emery cloth until the metal is bright. Then oil, grease, or paint the surface to prevent further rusting.

I. Glue.

1. *Dry glue.* The term "dry glue" is used for glue, such as cabinet-maker's or cooper's glue which is sold in the form of dry chips or powders. This kind of glue must be heated in a glue-pot or else in a double boiler. A home-made double boiler can be made by placing a tin can in a larger pot which has a few pieces of wood in it to keep the bottom of the can from touching the bottom of the pot.

   To heat dry glue, soak the chips or the powder overnight, or at least for several hours, in a little more water than it will absorb. Place this soaked glue in the inner can of the double boiler, surround it with water, and heat until the glue is well heated and uniform in thickness. It is then ready to use. The glue may be reheated repeatedly. It cools and "sets" very rapidly, therefore it is best to use it where the temperature is moderately warm. Everything should be ready so that the glue can be spread and the parts clamped or otherwise fastened immediately afterward. A good quality of dry glue is probably the best glue to use for cabinet and furniture work.
2. *Liquid glue.* Liquid glue has certain advantages. It may be purchased in small bottles or cans, is always ready for use, and requires no heating except in exceptionally cold weather when it may need to be warmed up by placing the can in warm water. The fact that liquid glue sets and hardens much more slowly than heated dry glue is often an advantage, for it gives more time properly to adjust the parts to be glued.

J. Nails, brads, screws, and other fasteners.

1. *Wire nails.* Most of the nails manufactured to-day are made of wire. They vary from 2 penny (2d.) to 60 penny in size. Nails 16 penny and larger are commonly called spikes.

   The term "nail" usually means that the fastener so named has a flat head. For example, 8d. common and all other common wire nails have flat heads. There are special forms of nails, such as finishing, flooring, and casing nails, which do not have flat heads, but have a small head characteristic of "brads."

   The nails shown above the number 1 in Fig. 27, illustrate various sized common wire nails. Those above the number 2 are brads with the exception of a six and an eight penny finishing nail. They were placed there to show that nails of equal length vary in thickness or gauge. For repair work on small parts it is

particularly well to know how to specify or describe the kind of brad or nail that is needed. Table 9 is given herewith to show the length and gauge number and the weight of nails and brads.

2. *Steel cut nails.* Steel cut nails are used to some extent for nailing fencing, sheathing, flooring, battens, and other objects. Cut nails are harder to drive and are more likely to split lumber than are wire nails.

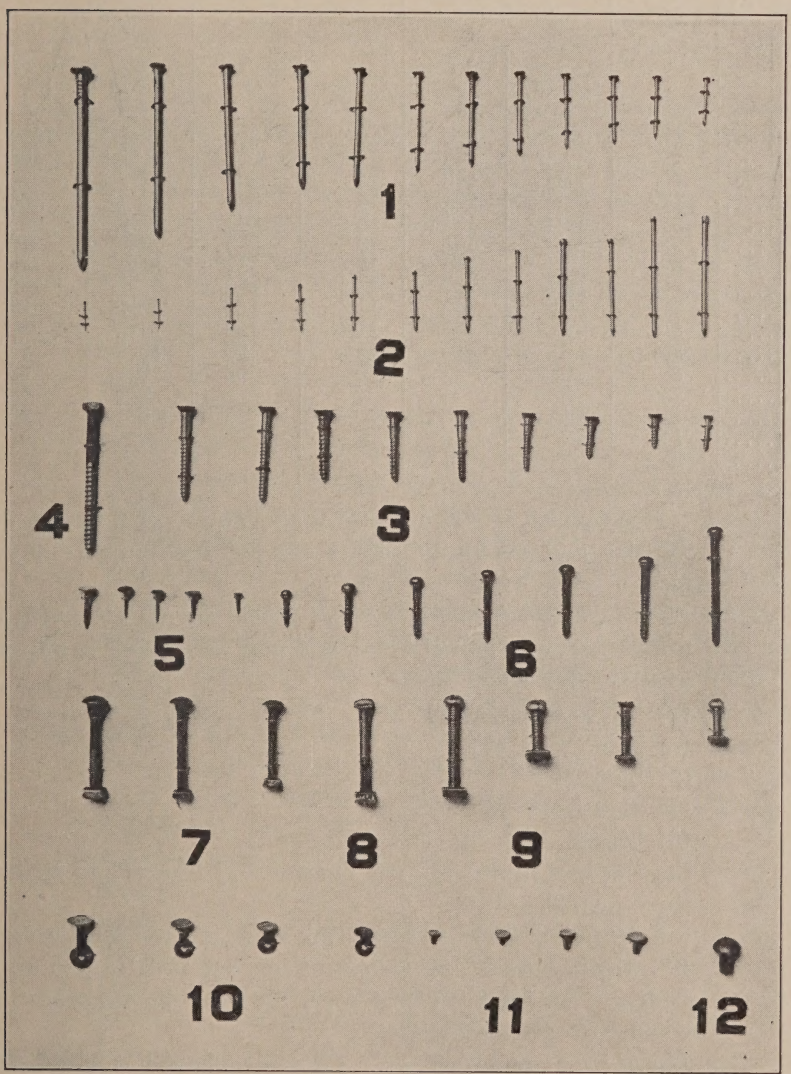


FIG. 27. NAILS, BRADS, SCREWS, ETC.

1. Common wire nails. 2. Wire brads. 3. Flat-head bright screws. 4. Lag screw. 5. Tacks. 6. Round head blue screws. 7. Carriage bolts. 8. Machine bolt. 9. Stove bolts. 10. Copper rivet and burrs. 11. Tinner's rivets (soft metal). 12. Iron rivet.

3. *Wood screws.*

a. *Styles of wood screws.* Wood screws are made with flat heads, round heads, fillister heads, and oval heads. Flat-head screws are shown above number 3, in Fig. 27. It will be noticed that screws of a given length are not necessarily of uniform thickness.

TABLE 9. LENGTH, THICKNESS, AND WEIGHT OF NAILS AND BRADS

SIZE	LENGTH IN INCHES	COMMON		FINISHING		CASING	
		GAUGE	NO. PER LB.	GAUGE	NO. PER LB.	GAUGE	NO. PER LB.
2d.....	1	15	876	16½	1351	15½	1010
3d.....	1¼	14	568	15½	807	14½	635
4d.....	1½	12½	316	15	584	14	473
5d.....	1¾	12½	271	15	500	14	406
6d.....	2	11½	181	13	309	12½	236
7d.....	2¼	11½	161	13	239	12½	210
8d.....	2½	10¼	106	12½	189	11½	145
9d.....	2¾	10¼	96	12½	172	11½	132
10d.....	3	9	69	11½	121	10½	94
12d.....	3¼	9	63	11½	113	10½	87
16d.....	3½	8	49	11	90	10	71
20d.....	4	6	31	10	62	9	52
30d.....	4½	5	24			9	46
40d.....	5	4	18			8	35
50d.....	5½	3	14				
60d.....	6	2	11				

Round-head screws are shown above number 6 in Fig. 27. Fillister and oval-head screws are not used much on the farm.

b. *Materials used in manufacture.* Wood screws are made of bright steel wire and of brass, and may be finished in various ways; as, for example:

(1) bright (steel color).
(2) blue.
(3) brass.
(4) nickel.
(5) bronze.

Steel screws are sometimes brassed and bronzed to imitate these metals.

Steel and brass wood screws are made in sizes varying from ¼″, 0 gauge, to 6″, 30 gauge. They are usually put up in packages of 1 gross (12 dozen), but may be purchased in smaller quantities if desired.

c. *Use of soap on wood screws.* Those who have not tried it will be agreeably surprised to see how much easier screws may be driven in hard or tough wood if common soap is applied on the screws.

Another way to make screws drive easily is to drill a hole slightly smaller than the screw before inserting the screw. The best tool to drill holes of small diameters is an automatic push drill, but other drills may be used. In the absence of any kind of a drill, a hole is sometimes made with a nail which is driven where the screw is to go, and is then pulled so as to leave a hole in which the screw will follow.

4. *Coach or lag screws.* Coach or lag screws are made, as shown above number 4, in Fig. 27, with gimlet points like other wood screws, but with a square head like that of a machine bolt instead of the slotted head found in ordinary wood screws.

   Lag screws are driven with a monkey wrench. They are used where wood parts need to be held securely and where bolts cannot be so easily used. Holes slightly smaller than the lag screws to be used should be bored before the latter are inserted, as otherwise the head may be turned off. Lag screws are made of iron or steel, and vary from ¼″ × 1″ to 1″ × 12″ in size.

5. *Bolts.* The bolts most frequently used by farmers are machine bolts, carriage bolts, and stove bolts. Each of these three varieties is used for a greater variety of purposes than the name implies.

   a. *Machine bolts.* Ordinary machine bolts have square or else hexagonal heads. The nuts are made to correspond in style. The threads are known as the U.S. Standard threads. The bolts are made from ¼″ × 1½″ to 1¼″ × 30″. A machine bolt is shown over number 8, in Fig. 27. Machine bolts are often used to bolt together wood, or wood and metal. They have this advantage over carriage bolts and stove bolts — the square or hexagonal head and nut give a good grip for a wrench so that little difficulty is experienced in tightening and removing them even though somewhat rusted. When used in wood, washers are usually inserted under the nut. When machine bolts are used on farm machinery in which there is much vibration, as in tractors, it is well to use a lock-washer under the nut.

   b. *Carriage bolts.* Carriage bolts are shown over number 7, in Fig. 27. It can readily be distinguished by the fact that it has a rounded head and a shank that is squared directly under the head. The squared shank is supposed to keep the bolt from turning when the nut is being tightened or loosened, but it does not always do so, particularly if the nut has rusted fast more or less, and when the wood is soft. Consequently it is sometimes quite a job to remove a carriage bolt. It is sometimes necessary to file the head flat on two sides or to cut a slot in the head with a hack saw or a file so that it may be

held with a wrench or a screwdriver while pressure is applied to turn the nut. A pipe wrench may hold the round head if a grip can be obtained.

c. *Stove bolts.* Stove bolts are easily recognized by the fact that they have slotted heads. These heads are round or flat, just as with wood screws. The nut on stove bolts is usually square. The slotted head permits the bolt to be adjusted with a screwdriver. Several are shown above number 9, Fig. 27.

d. *Expansion bolts.* Expansion bolts are very handy when it is desired to fasten objects to concrete, stone, or brick walls. A hole is drilled with a star drill and an expansion bolt is inserted. The bolts are so made that the bolt expands as the machine bolt or the machine screw in its center is turned, thus making a very firm fastening. They are made in sizes from ¼″ × 1¾″ to 1″ × 12″, the first figure in each case being the inside diameter and the second one in each case the length. The star drill must be of the same diameter as the outside diameter of the expansion bolt when the latter is unexpanded.

TABLE 10. WOOD AND MACHINE SCREW SIZES (DIAMETERS)

(The diameter of wood screws is measured with a screw gauge. The decimal equivalents of gauge numbers is given in Table 10.)

No. of Screw Gauge	Size of Numbers in Decimals (A.S. Co. Std.)	No. of Screw Gauge	Size of Numbers in Decimals (A.S. Co. Std.)	No. of Screw Gauge	Size of Numbers in Decimals (A.S. Co. Std.)
000.....	.03152	16	.26840	34	.50528
00.....	.04486	17	.28156	35	.51844
0.....	.05784	18	.29472	36	.53160
1.....	.07100	19	.30788	37	.54476
2.....	.08416	20	.32104	38	.55792
3.....	.09732	21	.33420	39	.57108
4.....	.11048	22	.34736	40	.58424
5.....	.12364	23	.36052	41	.59740
6.....	.13680	24	.37368	42	.61056
7.....	.14996	25	.38864	43	.62372
8.....	.16312	26	.40000	44	.63688
9.....	.17628	27	.41316	45	.65004
10.....	.18944	28	.42632	46	.66320
11.....	.20260	29	.43948	47	.67636
12.....	.21576	30	.45264	48	.68952
13.....	.22892	31	.46580	49	.70268
14.....	.24208	32	.47896	50	.71584
15.....	.25524	33	.49212		

6. *Rivets.*

a. *Copper rivets.* Several copper rivets and burrs are shown above number 10, in Fig. 27. They may be used for fastening a variety of materials. The end of the rivet should stick out beyond the burr only a short distance, perhaps ⅛″. If it

TABLE 11. LENGTHS AND CORRESPONDING GAUGE NUMBERS OF WOOD AND MACHINE SCREWS

(The length of flat-head screws is measured over all; the length of round-head screws includes half of the head; fillister head screws are measured from the rim of the head)

LENGTH OF SCREWS	CORRESPONDING GAUGE NUMBERS	LENGTH OF SCREWS	CORRESPONDING GAUGE NUMBERS
¼″	0 to 4 incl.	2 ″	5 to 24 incl.
⅜″	0 to 9 “	2¼″	5 to 24 “
½″	1 to 12 “	2½″	5 to 24 “
⅝″	1 to 14 “	2¾″	6 to 24 “
¾″	2 to 16 “	3 ″	6 to 26 “
⅞″	2 to 16 “	3½″	8 to 26 “
1 ″	3 to 20 “	4 ″	8 to 30 “
1¼″	3 to 24 “	4½″	12 to 30 “
1½″	3 to 24 “	5 ″	12 to 30 “
1¾″	5 to 24 “	6 ″	12 to 30 “

sticks out too far, it is difficult to upset or rivet down the end satisfactorily. Copper rivets from ¼″ to 1½″ long are sold with burrs in one-pound packages.

b. *Tinner's rivets.* Tinner's or soft metal rivets are shown above number 11, in Fig. 27. These rivets are sold in the black as well as in the tinned form. They are used for riveting sheet metal, and for repairing holes in kettles, as when a rivet is placed in a hole and then riveted down on both sides of the metal in such a way as to make a water-tight joint. Tinner's rivets may be purchased in assorted sizes.

c. A round or button-head steel rivet, such as is used for heavy sheet metal, is shown above number 12, in Fig. 27.

d. Tubular steel rivets are made of soft steel. They are used quite extensively in harness and other leather work.

7. *Corrugated steel fasteners.* A corrugated fastener is shown above number 7, in Fig. 28. They are made from ⅛″ to 1″ in length, and have from two to eleven corrugations. Corrugated fasteners are useful in holding together two adjoining parts or boards; as, for example, when the end piece in an apple box cracks, two or three of these fasteners will hold the parts together nicely.

8. *Staples.* Wire staples for fencing and for poultry netting are frequently used on the farm. Fencing staples are from ⅞″ to 2″ long, and poultry netting staples come in lengths of ½″, ⅝″ ¾″ and ⅞″. Staples are either galvanized, or have the bright wire finish. The latter rust quickly.

9. *Hinges.* The three types of hinges used most by farmers are shown in Fig. 28. Number 21 represents a T hinge, number 22 a butt hinge, and number 23 a strap hinge. Butt hinges should be "gained in" flush with the parts they hold together. Butt hinges are made in two styles as regards the pin that connects

the two parts of the hinge. This pin is either loose so that it may be drawn out, as in the case of the butt hinges usually

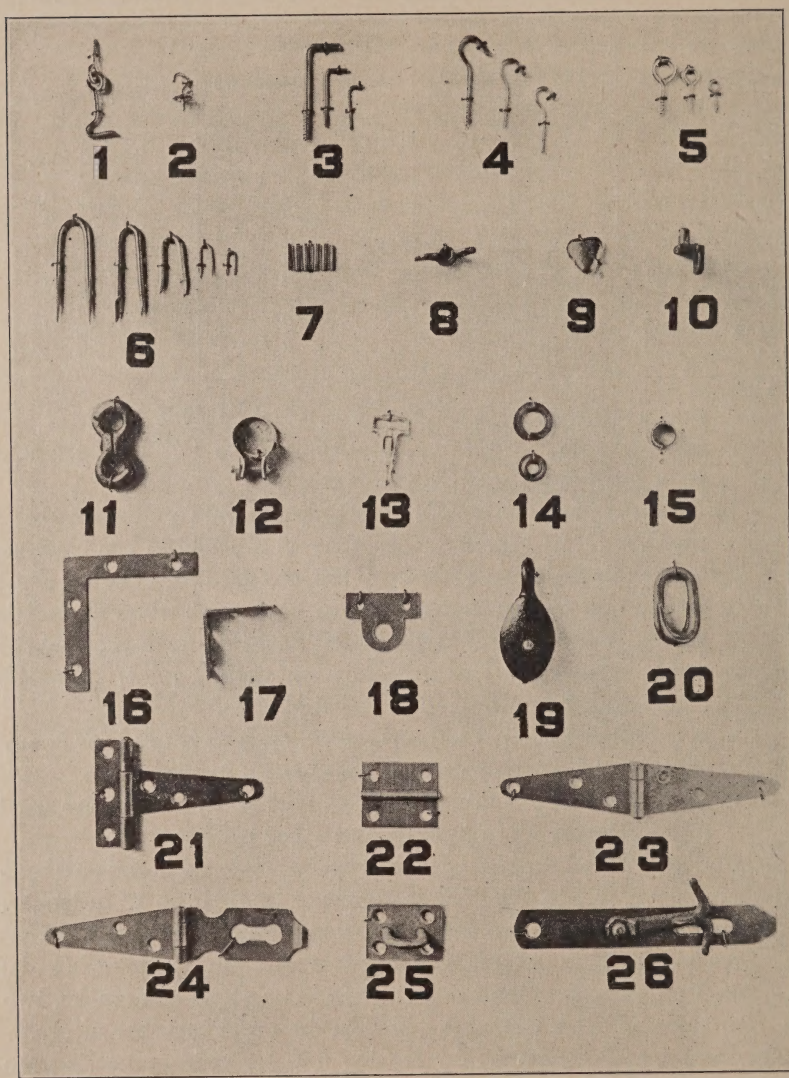


FIG. 28. COMMON ARTICLES OF HARDWARE

1. Hook and eye. 2. Cup hook. 3. Shoulder hooks. 4. Wire screw hooks. 5. Screw eyes. 6. Staples. 7. Corrugated steel fastener. 8. Wing nut. 9. Glider (or dome of silence). 10. Shelf block. 11. Patent link. 12. Hose clamp. 13. Snap. 14. Lock washer. 15. Brass ferrule. 16. Angle plate. 17. Corner brace. 18. Padlock eye. 19. Single steel pulley. 20. Open link. 21. Tee hinge. 22. Butt hinge (fast joint). 23. Strap hinge. 24. Steel hinge hasp. 25. Stationary staple. 26. Door hasp.

placed on house doors, or the pin may be riveted at the ends so that it cannot be removed, in which case the hinge is called a "firm-joint" butt hinge. Choice in the use between T and

strap hinges depends on which will give the greater strength for the door to be hung.

The hinges illustrated are made in a variety of sizes. All of them are made of steel, brass, and bronze, though steel and brass are used most. Sometimes they are made of steel and given a brass or copperized finish.

REFERENCES

A. Lumber.

Hodgson, F. T. *Estimating Frame and Brick Houses, Barns, Stables, and Outbuildings.* David Williams Co., 1913.

Griffith, Ira S. *Carpentry.* The Manual Arts Press, 1916.

Kidder, F. E. *Architects' and Builders' Pocket-Book.* John Wiley and Sons, 1916. (16th edition.)

Noyes, William. *Hand-Work in Wood.* The Manual Arts Press, 1910.

B. Cement and Concrete.

Campbell, H. Colvin, and Byer, Walter F. *Practical Concrete Work for the School and Home.* Prang Company, 1917.

Portland Cement Association, 111 W. Washington Street, Chicago. Free bulletins on: Foundations, Feeding-Floors, Fence-Posts, Milk-Houses, Septic Tanks, Silos, Troughs, Tanks and Cisterns, Walks, Steps, etc.

Eklaw, K. J. T. *Farm Concrete.* The Macmillan Co., 1917.

U.S. Department of Agriculture. Farmers' Bulletin No. 461, 1916, *The Use of Concrete on the Farm.*

Seaton, Roy A. *Concrete Construction for Rural Communities.* McGraw-Hill Book Co., 1918.

C. Pipe-fitting.

Dibble, Samuel Edward. *Elements of Plumbing.* McGraw-Hill Book Company, 1918.

Greenfield Tap and Die Corporation, Greenfield, Mass. Free Bulletin, *How I Fixed It.* 1921.

King, Alfred G. *Practical Steam and Hot Water Heating and Ventilating.* Norman W. Henley Co., 1913.

Starbuck, R. M. *Modern Plumbing Illustrated.* Chapter on "Country Plumbing." Norman W. Henley Co., 1917.

United States Army. *Plumbing.* Educational Manual No. 11, 1920.

D. Farm Blacksmithing.

Drew, J. M. *Farm Blacksmithing.* Webb Publishing Co., 1915.

Friese, John F. *Farm Blacksmithing.* The Manual Arts Press, 1921.

Googerty, Thomas F. *Practical Forging and Art Smithing.* Bruce Publishing Co., 1915.

Harcourt, Robert H. *Elementary Forge Practice.* The Manual Arts Press, 1920.

Schwarzkoff, Ernst, *Plain and Ornamental Forging.* John Wiley & Sons, 1916.

E. Soldering and Babbitting.

Hobart, James F. *Brazing and Soldering.* Norman W. Henley Co.

United States Army. *Sheet-Metal Work.* Educational Manual No. 24, 1920.

Williams, H. V. *The New Tinsmith's Helper and Pattern Book.* U.P.C. Book Co., New York, 1917.

F. Harness and Leather Repair.

Brace and Mayne. *Farm Shop Work.* Chapter LI. American Book Co., 1915.

Behrends, F. G. *Harness Repairing.* The Cornell Reading Course, Lesson 160, August, 1921.

Roehl, Louis M. *Harness Repairing,* Bruce Publishing Co., 1921.

War Department. *Manual for Farriers, Horseshoers, Saddlers, and Wagoners or Teamsters.* Document No. 486, 1914.

G. Paints, Varnishes and Stains.

Harrisons Inc. *Farmer's Paint Book.* (Free.) Philadelphia, Pa.

Sabin, A. H. *House Painting.* John Wiley & Sons, 1918.

U.S. Dept. of Agriculture, Washington, D.C. Farmers' Bulletin No. 474, 1918. *Use of Paint on the Farm.*

CHAPTER V

RELATING TO VEGETABLE GARDENING

Most persons living in rural communities and many living in suburban places are interested in vegetable gardening. The information contained in this chapter is limited to construction and repair work that is done in connection with plant production.

A Combination Flat and Germination Box

1. *Purpose.* Germination boxes are used to test the viability of seed. In other words, they are used to see what per cent of the seed will sprout when proper moisture and heat are present. The boxes used for this purpose may vary in size, but the one shown in Fig. 29 is made so that it can be used as an ordinary vegetable flat that will fit standard sized hotbeds or cold-frames after it has been used as a germination box.

   The saw kerfs are placed at uniform distances apart so that strings may be passed through them. The proper mixture of soil is placed in the germination box, and is tamped and leveled to a height up to where the saw kerfs begin. The strings are then run so as to lay off squares. A certain number of seeds is placed in each space and the whole is then covered with a damp cloth, and kept at a germinating temperature.

2. *Material required.*

   a. *Lumber.* Any scrap lumber such as box and crating lumber.

No. of Pieces	Dimensions	Purpose
2	$13/16'' \times 2'' \times 17\frac{5}{8}''$	Sides
2	$13/16'' \times 2'' \times 10''$	Ends
3	$13/16'' \times 3\frac{3}{4}'' \times 17\frac{5}{8}''$	Bottom

   b. *Hardware.* About 20 6d. or 8d. common wire nails.

   Note: The size of the nails to be used depends on the quality of the lumber, since some of it splits and cracks more easily than does other lumber.

   If the lumber at hand works up to better advantage by placing the bottom pieces crosswise instead of lengthwise, this may be done, though the flat is more usable if the bottom boards run lengthwise of the box.

3. *Directions.*

   a. Cut all of the material to the exact sizes given in the drawing and also in the bill of material.

   Lay the two sides side by side and mark them for the saw

kerfs. These are two inches apart from center line to center line of cut. The first saw kerf and the last one being $2\frac{13}{16}''$ from the ends (two inches plus the thickness of the end piece).

b. Mark the depth to which each saw kerf is to go. This is $\frac{1}{2}''$ according to the drawing.

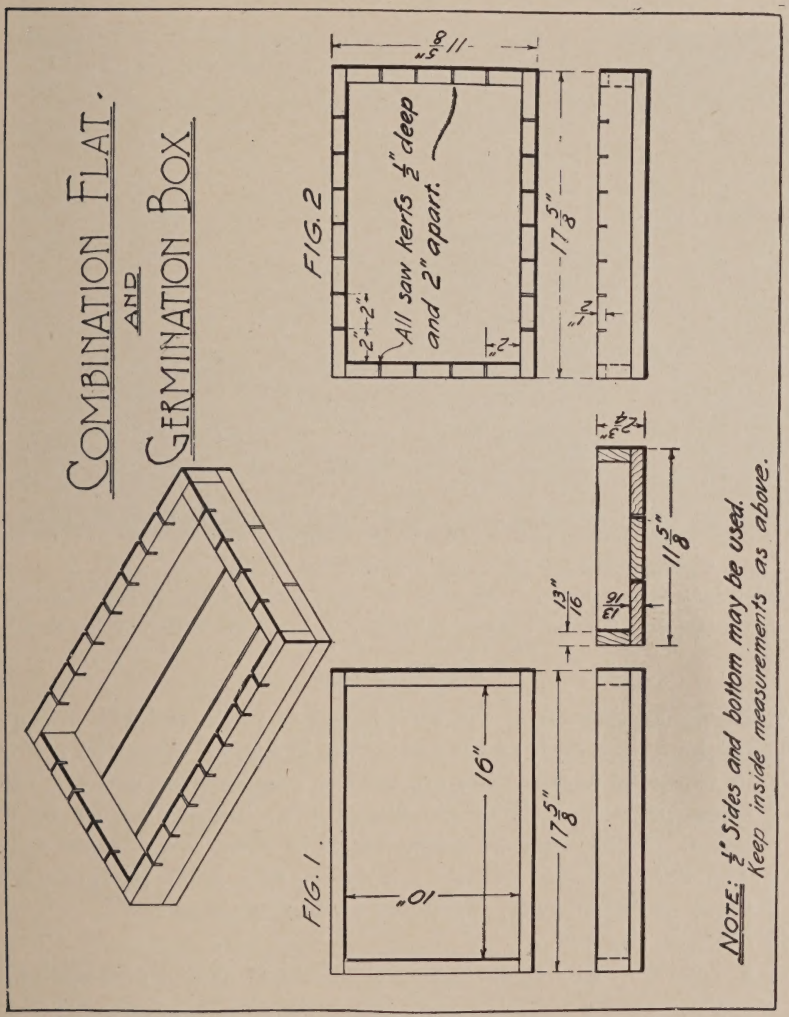

COMBINATION FLAT AND GERMINATION BOX
FIG. 2
All saw kerfs ½" deep and 2" apart.
FIG. 1.
NOTE: ¾" Sides and bottom may be used. Keep inside measurements as above.

FIG. 29. COMBINATION FLAT AND GERMINATION BOX

c. Saw the kerfs either with or without a miter box.

d. Mark and saw the end pieces in the same manner, but note that the first and last cut in each end are just 2″ from the end instead of $2\frac{13}{16}''$ as was the case with the sides. Look at the drawing and see why this is true.

e. Stand the two end pieces on end on the floor and lay a side piece

across them. The saw kerfs should all face the same way. Nail the side piece to the ends using two nails on each end, and apply a square to the corners to see that the angles are square.

f. Nail on the remaining side.

g. Nail on the bottom boards. Keep $\frac{1}{8}''$ or $\frac{3}{16}''$ joints between the bottom boards to allow for expansion and proper drainage.

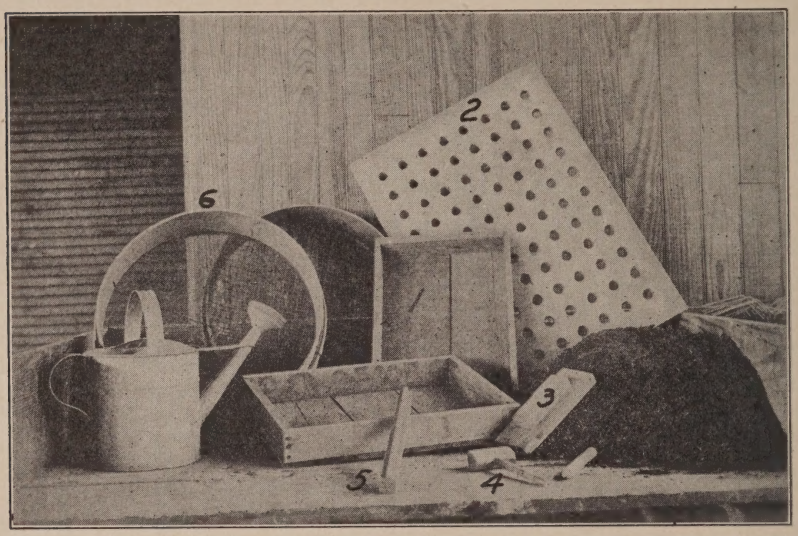


FIG. 30. EQUIPMENT USED FOR SOWING AND TRANSPLANTING AS ARRANGED BY THE VEGETABLE GARDENING DEPARTMENT OF THE PENNSYLVANIA STATE COLLEGE

1. Vegetable flat. 2. Spotting board. 3. Tamper. 4. Dibble. 5. Marker. 6. Soil sieve.

Vegetable Flat

1. *Purpose.* After seed has been tested as to its viability in a germination box, such as the one shown in Fig. 29, it may be planted in vegetable flats. They are used in green-houses, hotbeds, cold-frames, and sometimes are placed near sunny windows in the home. Plants may be transplanted in them one or more times. The flats are used without any fillers, with paper pots, and with paper or earth bands, depending on circumstances.

2. *Material required.*

a. *Lumber.* Any scrap lumber such as box lumber and crating.

NO. OF PIECES	DIMENSIONS	PURPOSE
2	$\frac{13}{16}'' \times 2'' \times 23\frac{1}{2}''$	Sides
2	$\frac{13}{16}'' \times 2'' \times 15\frac{1}{2}''$	Ends
4	$\frac{1}{2}'' \times 4'' \times 23\frac{1}{2}''$	Bottom

b. *Hardware.* About 24 6d. common wire nails.

3. *Directions.* The method of construction is similar to that of the combination flat and germination box explained under "A." The saw kerfs are omitted.

Tamper for Vegetable Flat

1. *Purpose.* A tamper is usually used to firm down the soil in vegetable flats before the seed is sown, or the plants are transplanted into it, as the case may be. A working drawing of a simple tam-

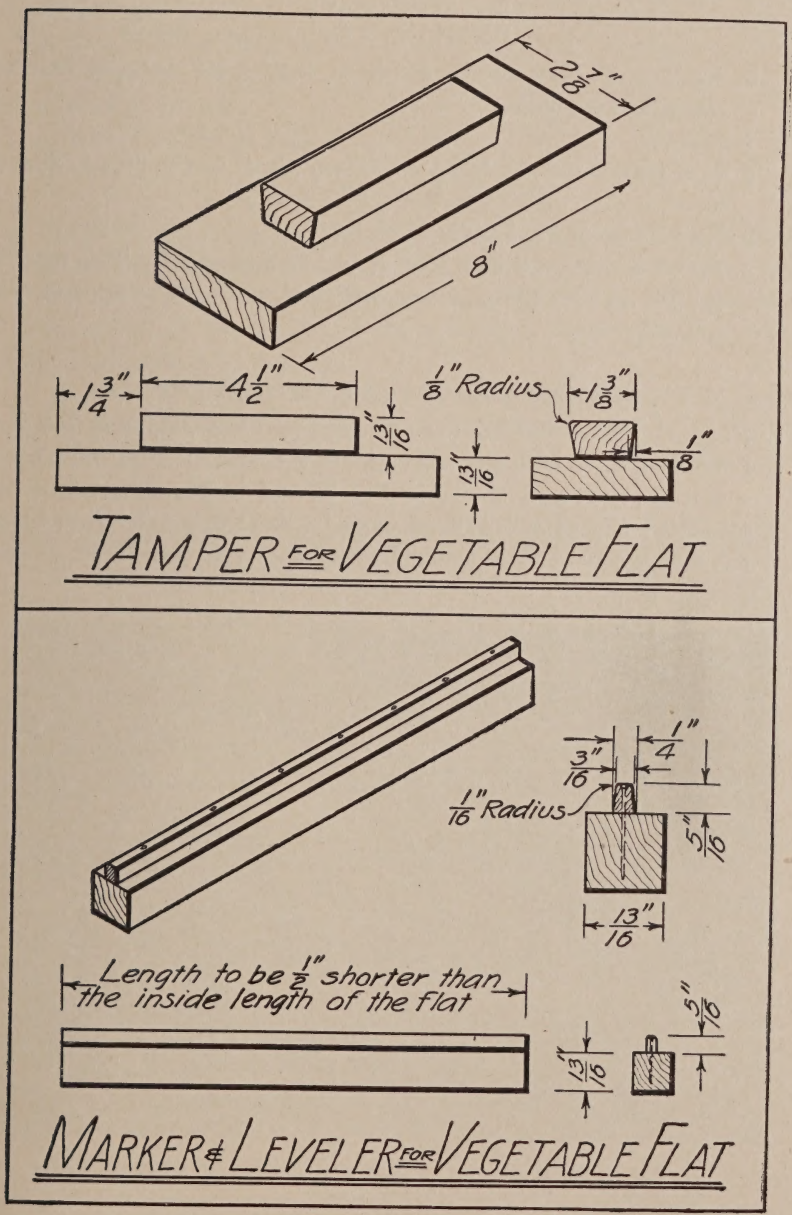


FIG. 31. TAMPER FOR VEGETABLE FLAT. MARKER AND LEVELER FOR VEGETABLE FLAT

per that can easily be made is shown in Fig. 31. A photograph of a tamper very similar in appearance is shown in Fig. 30.

2. *Material required.*

a. *Lumber.* White pine or other close-grained wood.

No. of Pieces	Dimensions	Purpose
1	$13/16'' \times 2\frac{7}{8}'' \times 8''$	Base
1	$13/16'' \times 1\frac{3}{8}'' \times 4\frac{1}{2}''$	Handle

b. *Hardware.* Two screws, flat-head, bright, $1\frac{1}{4}''$ long, or four 3d. common wire nails.

3. *Directions.*

a. Cut, plane, and sand-paper the two pieces to the proper dimensions.

b. Nail or screw the handle in place.

c. Finish if desired with a coat or two of linseed oil. This may be rubbed on with cotton waste, with a rag, or may be applied with a brush.

Marker and Leveler for a Vegetable Flat

1. *Purpose.* After soil has been tamped into the vegetable flat, it is leveled off flush with the top edges of the flat by using an edge of a marker, such as is shown in Fig. 31 and in Fig. 32. After this operation the marker is used to make the small drills into which the seed is sown. The method of making these drills is illustrated in Fig. 32.

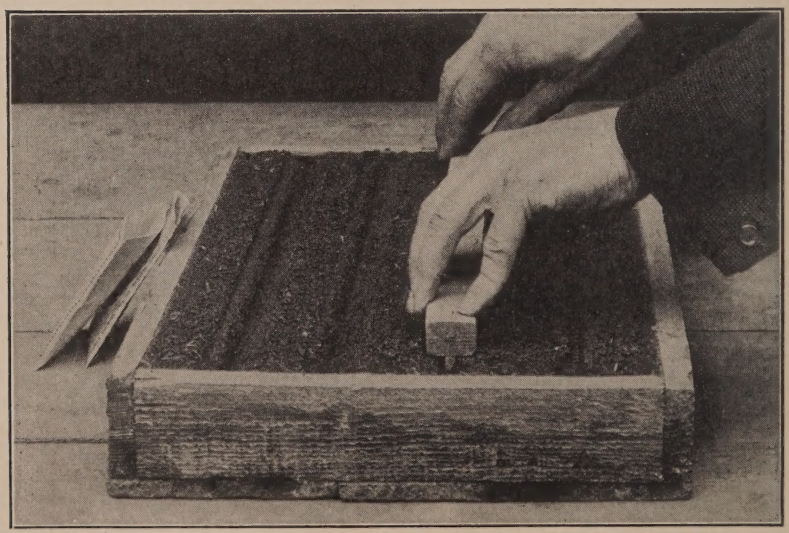


Fig. 32. A Marker and Leveler for Vegetable Flats in Use

2. *Material required.*

a. *Lumber.* White pine, yellow poplar, or other close-grained wood.

No. of Pieces	Dimensions	Purpose
1	$\frac{13}{16}''$ × $\frac{13}{16}''$ × a length equal to $\frac{1}{2}''$ shorter than inside length of flat.	Leveler
1	$\frac{1}{4}''$ × $\frac{5}{16}''$ × a length equal to $\frac{1}{2}''$ shorter than inside length of flat.	Edge for drills

b. *Hardware.* A number of $\frac{3}{4}''$, $\frac{7}{8}''$ or $1''$ wire brads.

3. *Directions.*
   a. Cut stock to sizes specified.
   b. Plane and sand-paper parts.
   c. Nail together.
   d. Finish if desired with linseed oil.

Spotting Board and Dibble

1. *Purpose.* Spotting boards are used in transplanting small plants to flats, or from one flat to another where the plants may have more room for growth than formerly. Figs. 33, 35, and 36 show various stages of the process, while a working drawing of a spotting board is shown in Fig. 34.

   The term "dibble" is applied to pointed sticks or steel points with which holes are made when transplanting plants. The one shown in Fig. 34 is designed to fit the spotting board shown in the same figure.

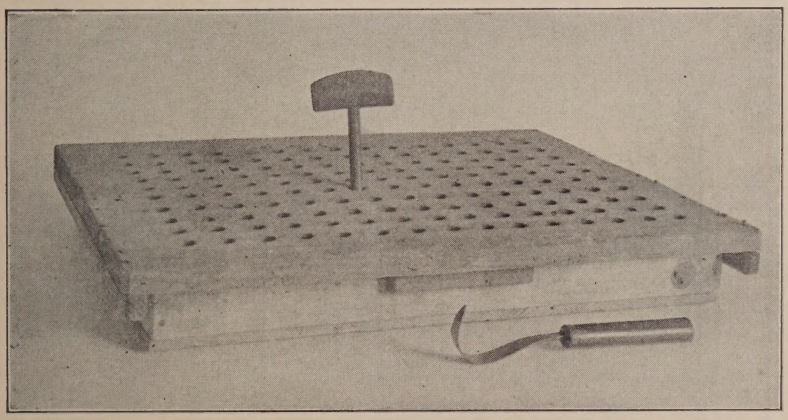


Fig. 33. The Spotting Board in Position

2. *Material required.* The spotting board is best made of white pine, though yellow poplar, cypress, and other woods may be used.

   The dibble illustrated in the same drawing is made of either soft or hard wood. A piece of broom-handle can well be worked into the shape desired.

   a. *Lumber.*

No. of Pieces	Dimensions	Purpose
4	$\frac{13}{16}''$ × $5\frac{1}{2}''$ × $27''$	Board
2	$\frac{13}{16}''$ × $1\frac{1}{2}''$ × $22''$	Edges
1	$\frac{1}{2}''$ × $\frac{1}{2}''$ × $30''$	Guide cleat
1	$\frac{13}{16}''$ round × $6''$	Dibble

b. *Hardware.* About 16 8d. finishing nails.

3. *Directions.*

a. Cut the boards about 1″ longer than needed so that they can be squared up later.

b. Glue together the four 27″ boards before planing or surfacing

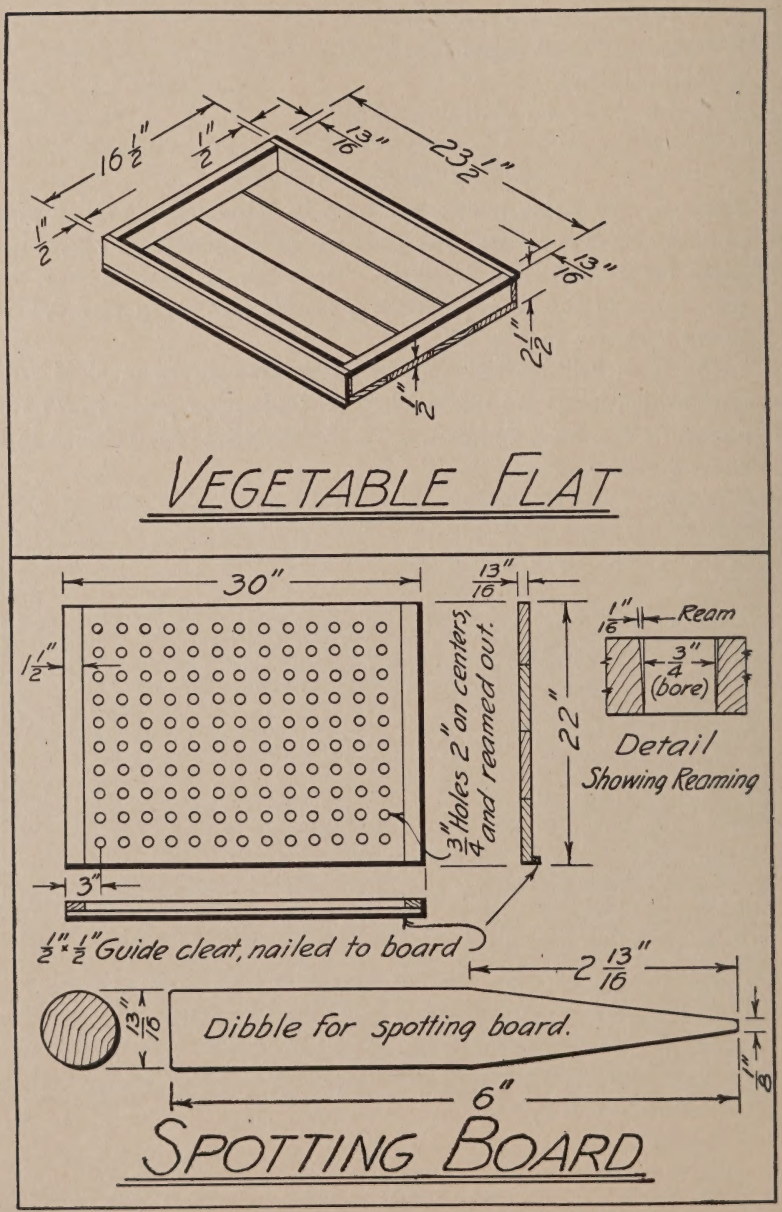


FIG. 34. VEGETABLE FLAT. SPOTTING BOARD

them. Keep the edges of the boards as flush as possible when gluing them. If the boards do not fit tightly, fit them with the longest plane you have.

c. After glue is hard, if the board is warped, plane diagonally or crosswise of the board until it is level, then finish by planing lightly with the grain.

d. Lay off the center lines with a framing square and straight edge (any straight piece of lumber of proper length).

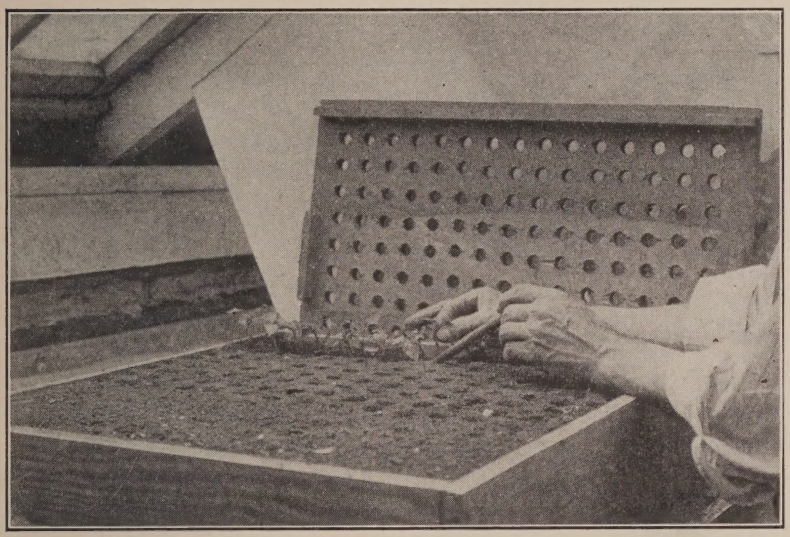


FIG. 35. PLANTS BEING SET IN HOLES MADE WITH THE SPOTTING BOARD

e. Place scrap lumber directly under points where holes are to be bored. Rest the knee on the board so that the board will fit up tight against the scrap lumber, and then bore the holes. This will prevent the auger bit from splintering the edges on the under side of the board. Use center lines only, to indicate where holes are to be bored. Bore the holes as squarely as possible to the surface of the board.

f. Ream out the holes as shown in the working drawing by using the end of a half round cabinet file, or with sand-paper wrapped over a rounded stick.

g. Square up the ends of the board and cut them off.

h. Nail or screw on the end strips.

i. Nail on the ½″ × ½″ guide cleat.

j. A drawing knife, spoke shave, or hand axe may be used in "roughing off" the wood from the tapered end of the dibble. Finish up the job with a plane or cabinet rasp followed by sand-paper. Complete the point of the dibble before cutting the dibble from the broom-handle or long stick that is used.

Soil or Manure Sieves (Hand Size)

1. *Purpose.* Sieves of various degrees of fineness are used in sifting sand, loam, and manure that is used in potting plants, in flats,

FIG. 36. PLANTS READY FOR THE GARDEN

Figures 32–36, inclusive, show stages in the use of the spotting board and flats as used by the Vegetable Garden Department of the Pennsylvania State College.

and in other seed-beds. Fig. 30 illustrates commercial hand sieves, while Fig. 37 shows one that is home-made, and very satisfactory.

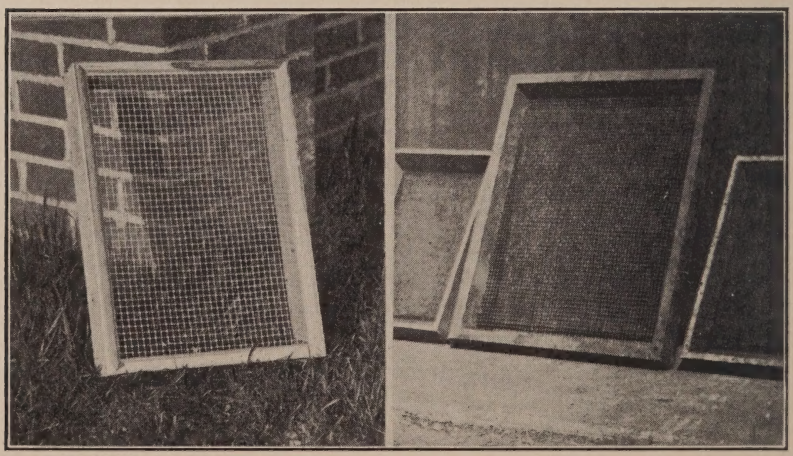


FIG. 37. HAND SOIL-SIEVES SHOWING HOW WIRE CLOTH IS FASTENED

Made by boys at the Vocational School, Lampeter, Pa., under the direction of Mr. S. R. Zug.

2. *Material required.*

a. *Lumber.* White pine, poplar, or other wood.

No. of Pieces	Dimensions	Purpose
2	$1\frac{3}{16}'' \times 3'' \times 18''$	Sides
2	$1\frac{3}{16}'' \times 3'' \times 11''$	Ends
5 lineal feet	$\frac{1}{2}''$ half round moulding	To hold wire

b. *Hardware.*

1 pc. 12″ × 18″ hardware cloth 3 squares per inch.
1 doz. 6d. common wire nails.
2 doz. flat-head carpet tacks No. 6.
2 doz. 1″ wire brads.

3. *Directions.*

a. Cut the sides and end pieces, making certain that parallel pieces are exactly the same length, and cut square at both ends.
b. Plane the sides and ends on all sides.
c. Assemble and nail the end pieces between the sides, using about three 6d. nails for each joint. Apply a square to the corners while nailing to make sure they will be true.
d. Nail the hardware cloth on to the frame with carpet tacks, placing them about 3″ apart. They should be covered with ½″ moulding.
e. Cut the moulding at 45 degrees in a home-made miter box or apply a square, using 8″ on the blade and 8″ on the tongue for the cut, and nail in place with ¾″, ⅞″, or 1″ wire brads.

Soil or Manure Sieve (Stationary Type)

1. *Purpose.* Sieves of the type illustrated in Fig. 186 have a variety of uses. They are used for screening garden soil, gravel, manure, and for removing hair from patent plaster when that is desired. Other uses may suggest themselves.

The screen is placed at a steep angle to the ground and then the material is thrown against the screen, thus separating it with the desired degree of fineness.

2. *Material required.*

a. *Lumber.* Yellow pine, or other lumber.

No. of Pieces	Dimensions	Purpose
2	1″ × 4″ × 5′	Sides
2	1″ × 4″ × 2′ 6″	Cross ties
2	1″ × 2″ × 4′ 6″	Legs
1	1″ × 2″ × 2′ 6″	Cross tie

b. *Hardware.*

One piece of hardware cloth of the desired mesh.
1 lb. ⅞″ galvanized wire staples.
Two ¼″ × 2″ machine bolts with washers.

Screened Frame for Cucurbits

1. *Purpose.* The term "cucurbits" is used for plants such as cucumbers, melons, squash, and pumpkins that belong to the same family. Melons, cucumbers, and others of this family are attacked in many places by the striped and by the spotted cucumber beetles and by other insect pests. The frame shown in Fig. 38 is designed to protect the plants from insect pests while the plants are young,

and need protection most. The frames are stored away when not in use, and may be used year after year.

2. *Material required.* The sides may be made of any scrap lumber.

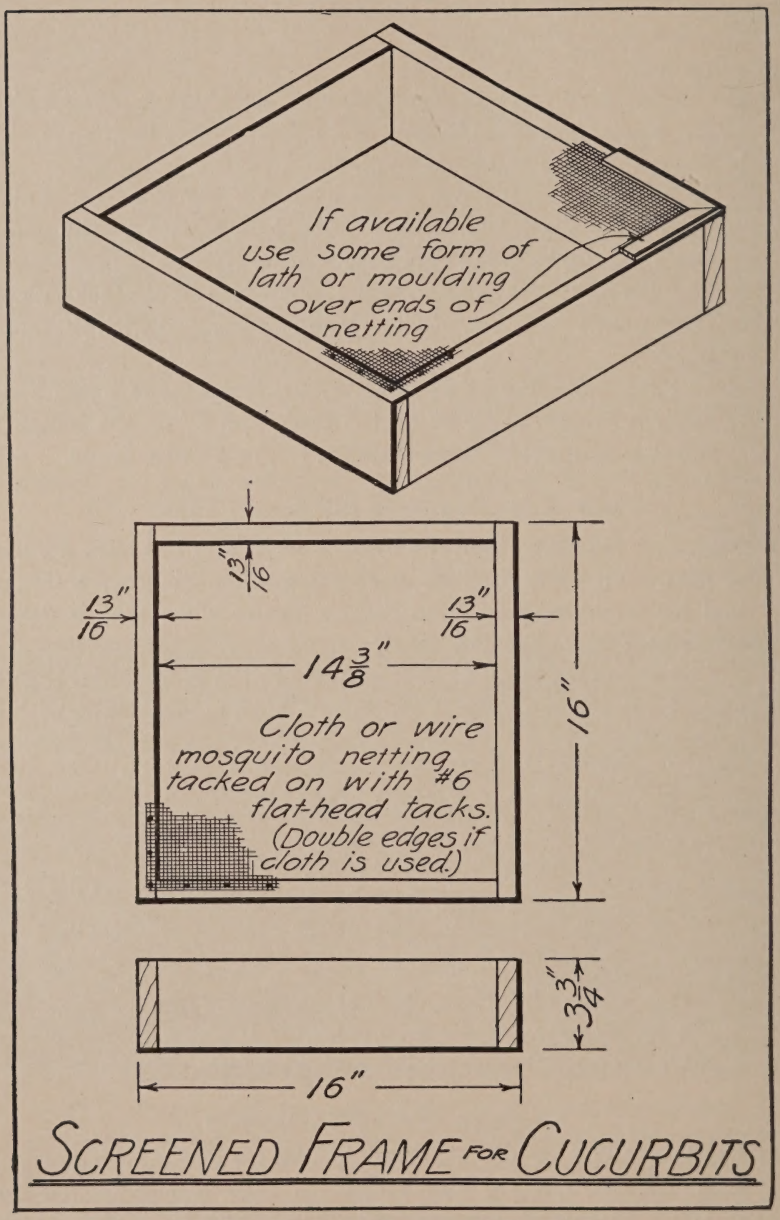

If available use some form of lath or moulding over ends of netting
13/16"
13/16"
13/16"
14 3/8"
16"
Cloth or wire mosquito netting tacked on with #6 flat-head tacks. (Double edges if cloth is used.)
3 3/4"
16"
SCREENED FRAME FOR CUCURBITS

FIG. 38. SCREENED FRAME FOR CUCURBITS

Knot-holes and other imperfections can be covered with patches of tin so as to make the frame insect proof.

The screening material may be either cloth or wire. Cloth will last two or three seasons if well taken care of. Galvanized wire screen having about fourteen wires per inch is better, and more permanent, but also requires a greater outlay of money to begin with.

Bill of material

a. *Lumber.*

No. of Pieces	Dimensions	Purpose
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 16''$	Sides
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 14\frac{3}{8}''$	Ends
4	$\frac{1}{4}'' \times 1\frac{3}{16}'' \times 16''$	Moulding

b. *Hardware.*

1 pc. mosquito netting $16'' \times 16''$.
2 doz. No. 6 flat-head tacks.
2 doz. $\frac{3}{4}''$ wire brads.

3. *Directions.*
   a. In cutting sides and ends, make sure opposite sides are of uniform length.
   b. The lumber need not be dressed (planed), but it makes a little better job to do so.
   c. The moulding shown over the screen may be left off if desired.
   d. Suit the size of the screen to your particular requirements.

Glass-Covered Forcing Box

1. *Purpose.* The glass covered forcing box is similar in construction and in purpose to the screened frame just described. The forcing box having a glass top will force plants more quickly than a screened frame will in cool weather, and it also keeps off injurious insects.

   Forcing boxes are used for melons and other cucurbits, especially where the growing season is relatively short and where growing conditions are not so good as they ought to be.

2. *Materials required.*
   a. *Lumber.* Any scrap lumber.

No. of Pieces	Dimensions	Purpose
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 11''$	Sides
1	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 11\frac{3}{8}''$	Front
1	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 11\frac{3}{8}''$	Back

   b. *Hardware.*

12 6d. common wire nails.
4 6d. finishing nails.

   c. *Glass.* 1 pc. $10'' \times 12''$ either single or double strength glass.

3. *Directions.*
   a. In cutting the bevel for the front and back pieces, use a rip-saw or rough-off the material with a hand axe and finish with a plane.
   b. In order to hold the glass in position, use 6d. finishing nails as shown in the drawing, Fig. 39. Drive the nails in place, then

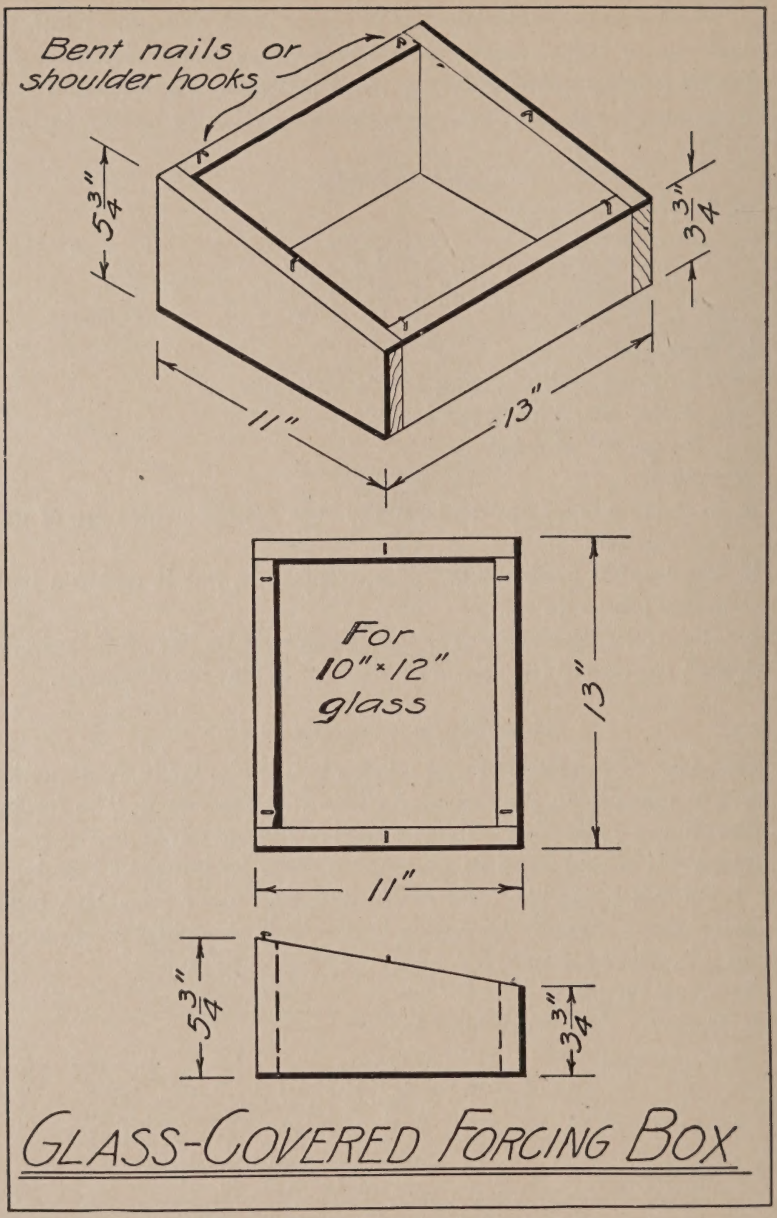


FIG. 39. GLASS-COVERED FORCING BOX

with a pair of pliers bend over the tops so as to form a shoulder hook.

c. Adapt the size of the box to the size of glass available. Figure that the glass will come to the center of all four edges, thus permitting space for the nails or shoulder hooks that hold the glass in place.

d. Place the box with the front or low edge facing south.

Potting Bench

1. *Purpose.* Potting benches are necessary wherever much potting or transplanting is done, as in connection with greenhouses, or in agricultural schools where vegetable gardening and floriculture are taught.

FIG. 40. SHOWING THE TYPE OF POTTING BENCHES USED AT THE PENNSYLVANIA STATE COLLEGE

For the sake of convenience, bins for sand, loam, and manure are sometimes placed under the potting bench, as in Fig. 40. A drawing of a potting bench is shown in Fig. 41.

2. *Material required* (for one unit).

a. *Lumber.* Yellow pine, cypress, cedar, or chestnut.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{4}'' \times 3\frac{5}{8}'' \times 29''$	Legs
1	$1\frac{3}{16}'' \times 11\frac{1}{2}'' \times 32''$	Front base
3	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 30''$	Aprons
4	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 30''$	Back
8	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 30''$	Sides
4	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 30''$	Bottom
2	$1\frac{3}{4}'' \times 3\frac{5}{8}'' \times 30''$	Cleats for floors
2	$1\frac{3}{4}'' \times 3\frac{5}{8}'' \times 30''$	Plates

b. *Hardware.* 8d. common and 8d. finishing nails.

3. *Directions.*

a. Cut material for floor. Nail same to cleats, using a square to line up the pieces.

b. Toe-nail uprights to the bench floor and nail $1\frac{3}{4}'' \times 3\frac{5}{8}'' \times 30''$ plates on top of uprights as shown in Fig. 40.

c. Nail the back, sides, and front on the uprights, using a square or a plumb to make sure the sides will be vertical.

d. Nail the top on, plane it smooth, and fasten the back and side aprons in place.

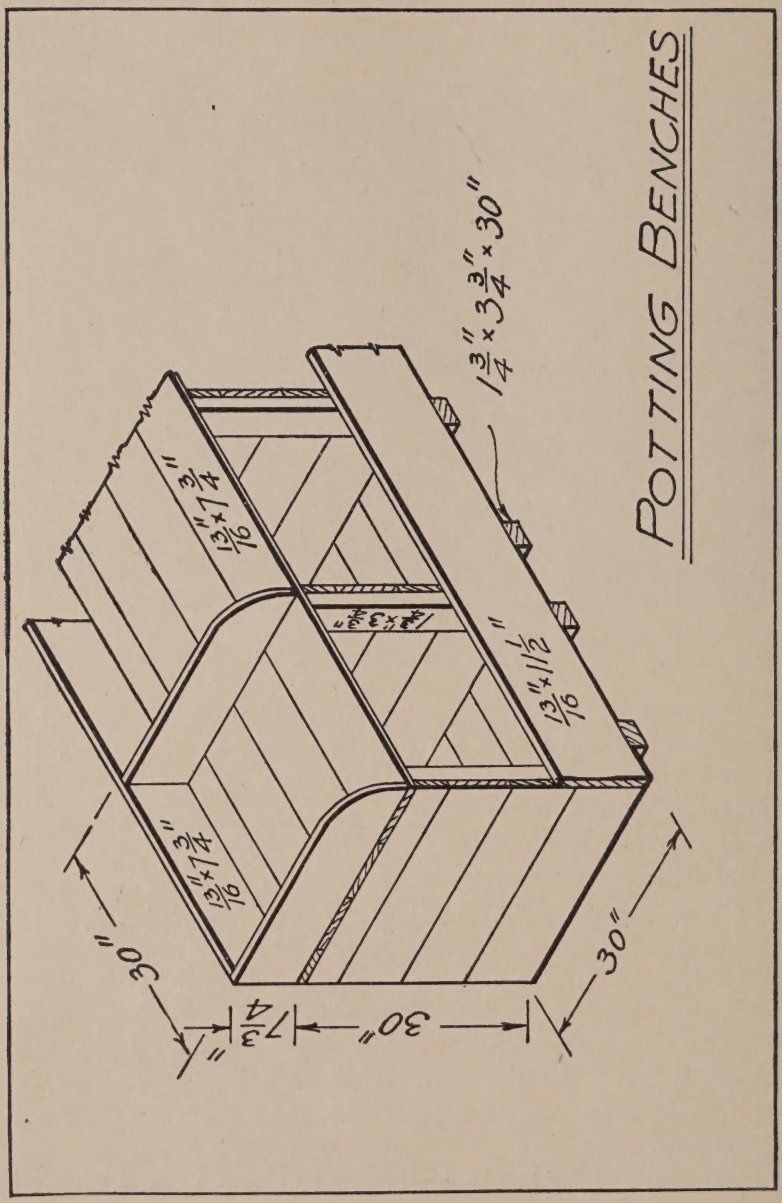


Fig. 41. Potting Benches

Garden and Lawn Roller of Concrete

1. *Purpose.* A roller, such as is shown in Fig. 42, may be used for a variety of purposes. In the early spring-time it is used to level up a lawn that has been raised unevenly by the frosts of winter. A

little later the roller may be used over grass and other seed-beds, for crushing clods, and for compacting soil as on a tennis court.

A concrete roller is more satisfactory than one made of wood, and less expensive than one made of sheet metal.

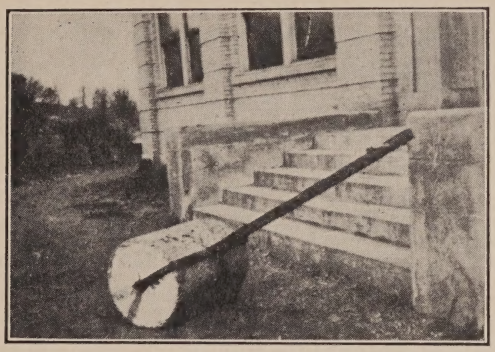


FIG. 42. CONCRETE ROLLER
Built by boys under the direction of Mr. A. E. Mack, at the Towanda, Pa., High School.

2. *Materials required.* The handle of an old lawn-mower may be used to advantage as a handle for the roller. The material needed for the roller shown in Fig. 43 is as follows:

a. *Concrete.*

3½ cubic feet of 1:2:3 mixture required.

1 sack of Portland cement
2 cu. ft. sand
3 cu. ft. stone or gravel
} will make 3.9 cu. ft. of mixture.

b. *Lumber.*

2 pcs. 1″ × 12″ × 2′ for bottom of form.
24 lineal ft. 1″ × 2″ for form.
1 pc. 1¾″ × 1¾″ × 3′ for handle.

c. *Hardware.*

One ½″ round rod 27″ long, or piece of ½″ pipe.
Four ½″ washers.
Two cotter pins, 1½″ long or two ½″ nuts, or else 2 caps to fit pipe if it is used instead of rod.
1 pc. ¾″ pipe, 13″ long, with cap screwed on each end for handle to lawn-mower.
2 machine bolts ¼″ × 2½″.
2 machine bolts ¼″ × 2″.
1 pc. of sheet iron or tin, 24″ × 51″ (allows ¾″ lap).
20 lineal feet of baling wire.

3. *Directions.*

a. Construct the base for the form by nailing two pieces of 1″ × 10″ × 24″ side by side to two 1″ × 2″ battens.

b. Draw diagonals, thus locating exact center of base. With this as a center draw a circle having a radius of 8″, or a diameter of 16″.

c. Nail four cleats of 1″ × 2″ material tangent — that is, just touching this circle on the outside edges, spacing these cleats equally around the circumference.

d. Toe-nail an upright piece 1″ × 2″ × 22⅜″ at the points of tangency.

e. To hold the top of the form in shape, use four cleats nailed together so as to form a four-sided figure, the inside edges of which are tangent to a 16″ circle. It does not matter whether an accurate square is formed just so that all cleats touch the circle. This top piece can be nailed together around the circle on the base of the form.

f. Nail the cap just made on top of the four uprights.

g. Rub axle grease or other grease over the inside of the tin where it is to come in contact with the cement. Next insert the tin or sheet metal into the form. Fasten baling or other wire entirely around it in four places so as to help it retain its proper shape, the wires being placed around the tin, but inside the wooden upright parts of the form.

h. Fasten a 1″ × 2″ strip over the top in such a way as to hold the upper end of the rod or pipe being used as an axis directly in the center. A hole is bored in this strip to correspond to the one in the base of the form. Insert the rod or pipe. (See m, below.)

i. Mix the sand and cement thoroughly before applying water. Add enough water so that the mixture tends to flatten out when piled in a heap.

j. While pouring the cement, use a piece of band iron or a wooden paddle along the inside of the form in such a way as to cause any air bubbles to escape that might be formed in pouring the cement.

k. Keep in a cool, shady place. As soon as the concrete is hard enough to be self-sustaining, remove the forms. Patch up any imperfections with a 1 to 1 mixture (1 part cement to 1 part sand) and smooth up the ridge that may have been formed where the form joined together.

l. A cement-water wash made of equal parts of cement and sand, to which water is added until it flows freely, may be painted over the concrete work. Use a whitewash or a cement worker's brush for the purpose.

m. The method of fastening the handle will depend on whether or not the central axis is a steel bar or a piece of iron pipe.

(1) If it is a steel bar, either drill holes for cotter-pins at each end or cut threads on the ends and use machine nuts. These operations should be performed before the rod is surrounded with concrete.

(2) If a piece of iron pipe is used, have pipe threads cut on the ends before pouring the concrete, and use pipe caps to hold the handle in place.

n. Oil bearings well while using the roller as there is considerable friction, and store in a dry shady place while not in use.

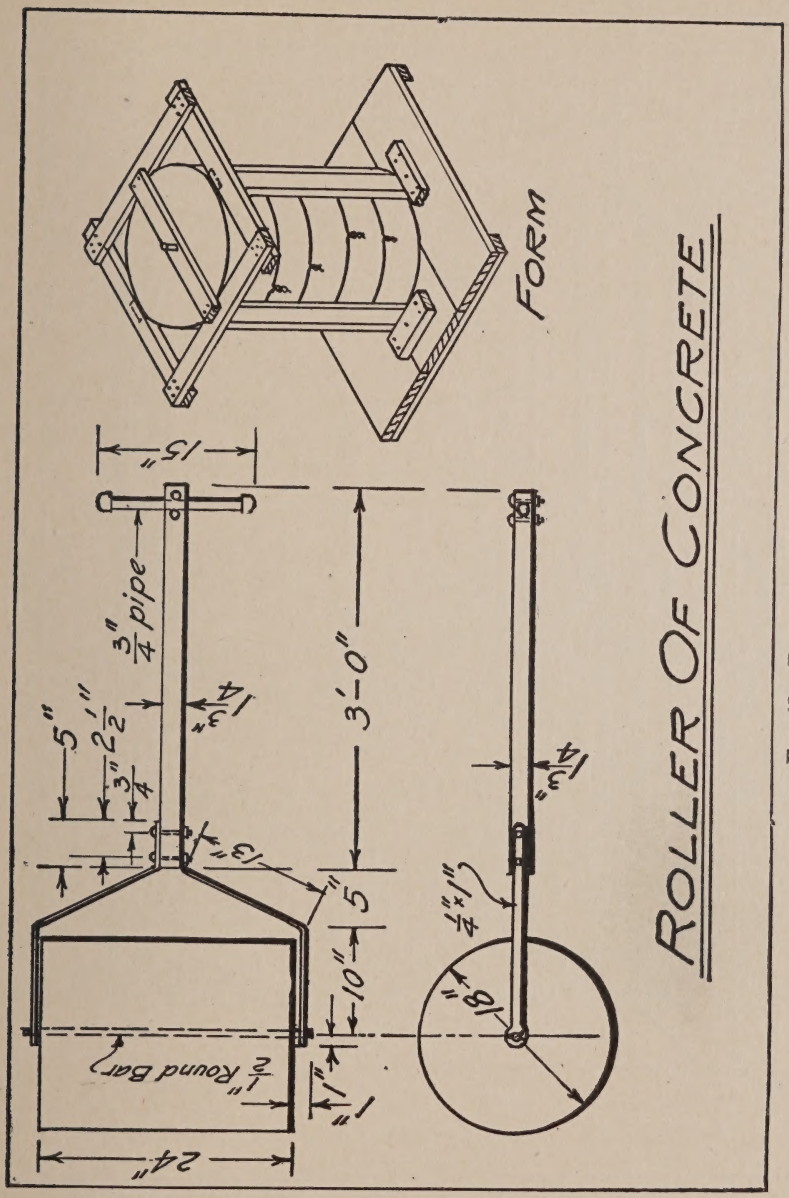


FIG. 43. ROLLER OF CONCRETE

Green-House Bench

1. *Purpose.* A green-house bench, such as shown in Fig. 44, is frequently used where flowers, such as roses, carnations, and chrysanthemums are grown, and for vegetable plants, such as cabbage, tomatoes, egg-plant, and peppers. The benches are usually about 30″ high from the ground to the top of the boards

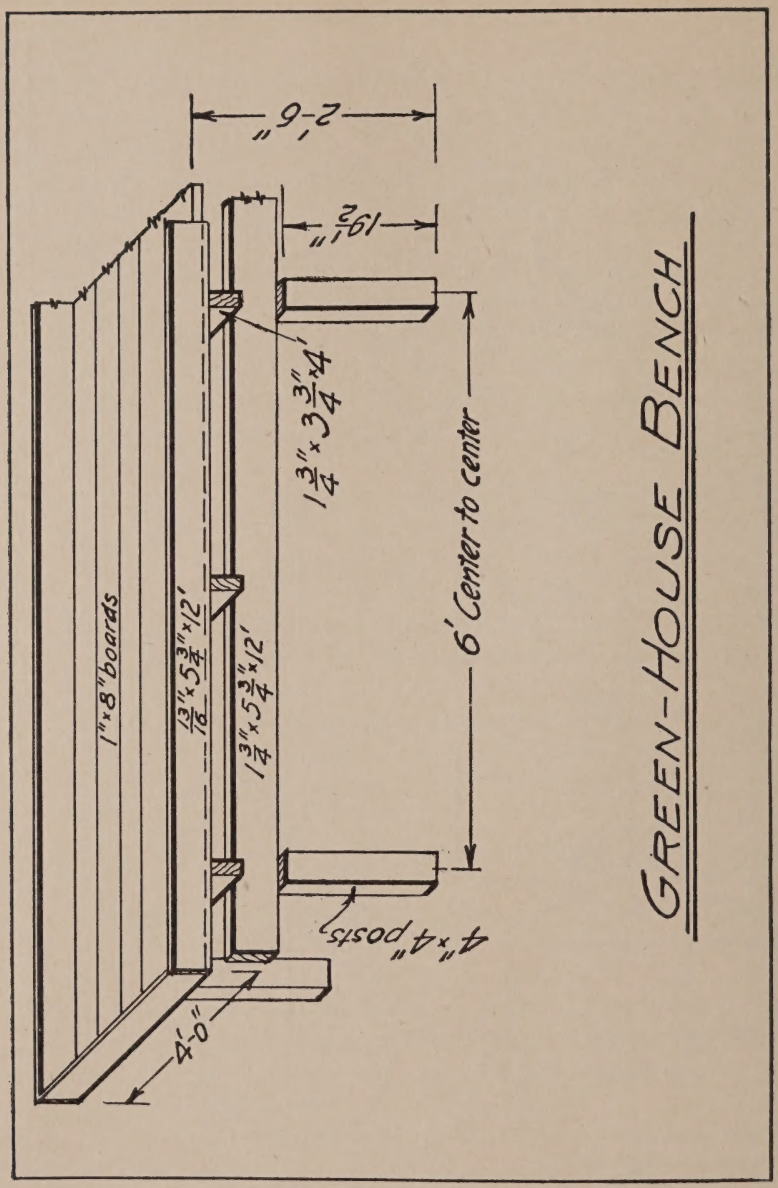


FIG. 44. GREEN-HOUSE BENCH

forming the bench top. In width they vary from 3′ 6″ to 6′. Those that can be approached from one side only being not over 3′ 6″ wide.

2. *Material required.* The material to be used depends in large part on the local supply. In the Pacific Northwest red cedar is relatively cheap and is durable; in the South and East pecky cypress is frequently used. Any wood that resists decay brought about by

moisture, heat, and changing temperature, and that is not too expensive, will serve the purpose.

Bill of material

(For a bench unit 12′ long. See Fig. 44)

a. *Lumber.*

No. of Pieces	Dimensions	Purpose
6	4″ × 4″ × 19½″	Legs
2	1¾″ × 5¾″ × 12′	Stringers
5	1¾″ × 3¾″ × 4′	Cross-ties
2	13/16″ × 3¾″ × 4′	Ends
2	13/16″ × 3¾″ × 12′	Sides
6	1″ × 8″ × 12′	Bottom

b. *Hardware.*

1 lb. 8d. common wire nails.

1 lb. 16d. common wire nails.

3. *Directions.*

a. Cut and place the posts in position. Six feet on centers lengthwise and 3′ on centers crosswise. With 16d. nails fasten the

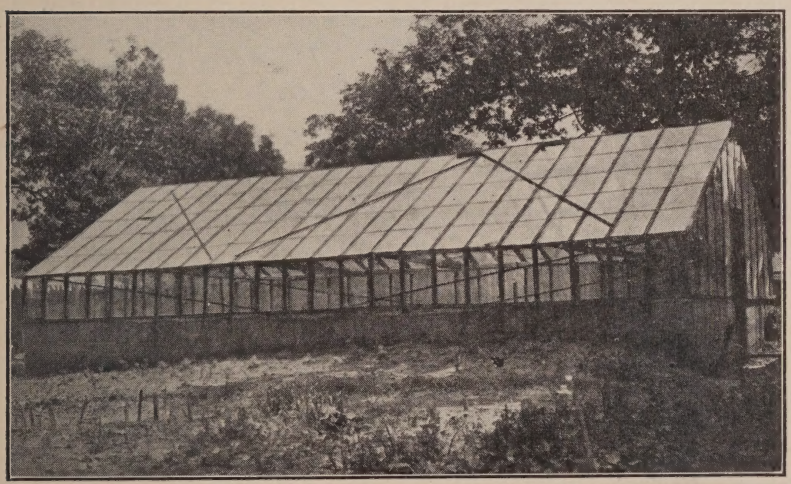


Fig. 45. A Green-House

Built completely by high school boys under the direction of Mr. D. D. Sheppard at Ash-Grove, Mo.

stringers on top of the posts, placing the stringers across the centers of the posts and edgewise.

b. If necessary brace the stringers by nailing strips diagonally across the lower edge of the stringers.

c. Nail the cross-pieces edgewise on top of the stringers, using 16d. nails, and spacing them 3′ on centers beginning with the points directly over the first pair of posts.

d. The floor may be laid loose or can be fastened to the cross-ties beneath it. Joints, if made, should preferably be made over cross-pieces. Lay the floor lengthwise. This permits the use

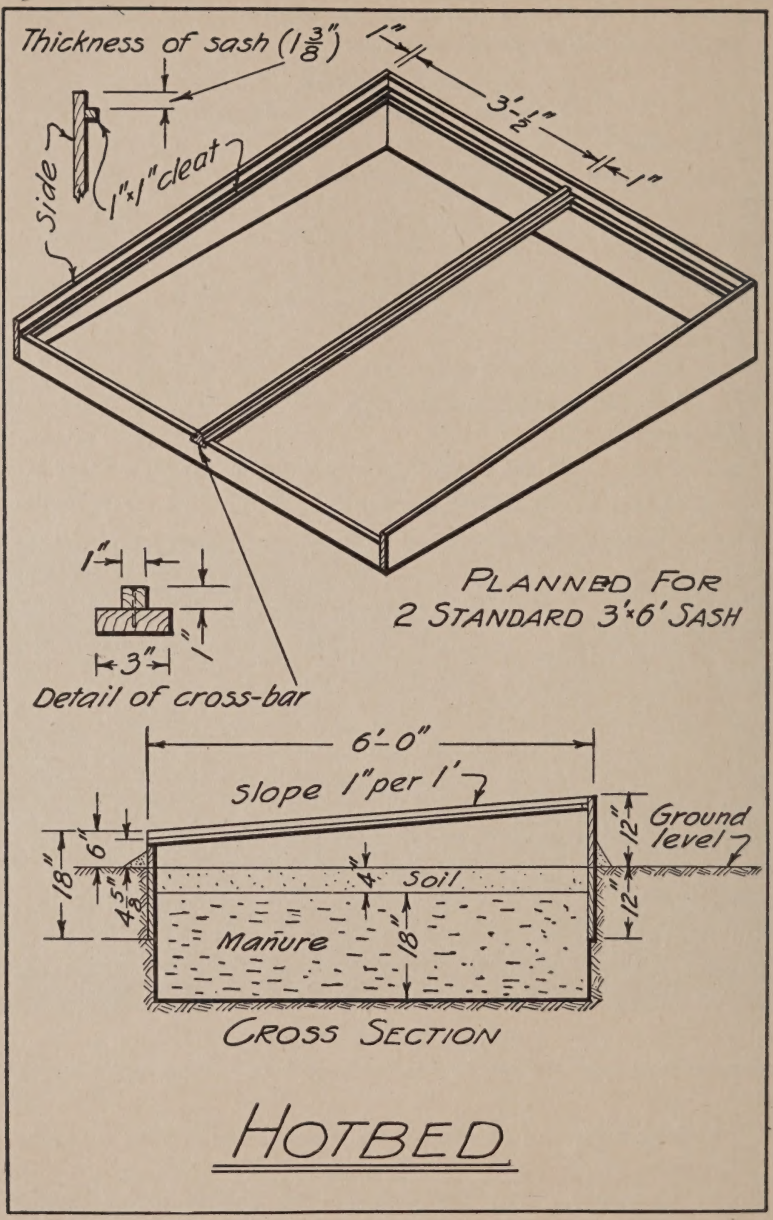


FIG. 46. HOTBED

of random lengths of lumber if the bench is of considerable length. It is best not to "break" all the joints of the floor on any one cross-piece.

e. Nail the ends and sides in place.

Hotbed (Wood, Pit Type)

1. *Purpose.* Hotbeds are used to "force" plants; that is, seed is sown and plants are grown in them earlier and faster than they could be grown in the garden at that season of the year. This is largely due to the heat or warmth that may be supplied by means of hotbeds, and the protection that the frame affords. The heat is supplied from two sources, namely, sunlight that comes through the hotbed sash, and heat caused by the decomposition of fresh horse manure which is placed in the pit built for the purpose.

   A cold-frame differs from a hotbed in that a cold-frame is not supplied with undecomposed horse manure. After a hotbed has lost its internal heat, it becomes a cold-frame.

2. *Material required.* Standard sized hotbed sash are 3′ × 6′. It is usually cheaper to buy them factory-made than to make them by hand. Sometimes ordinary window-sash can be purchased cheaply. These may serve the purpose, but the hotbed will want to be made to fit them.

   The following material is required for the hotbed illustrated in Fig. 46.

   a. *Lumber.*

No. of Pieces	Dimensions	Kind	Purpose
1	1″ × 6″ × 6′–2″	Cypress	Front
1	1″ × 12″ × 6′–2″	Cypress	Front
2	1″ × 12″ × 6′–2″	Cypress	Back
4	1″ × 12″ × 6′–0″	Cypress	Sides
32 lineal feet	1″ × 1″	Cypress	Guide Strips
1	1″ × 3″ × 6′–0″	Cypress	Cross-bar
2 standard	3′ × 6′ hotbed sash	Cypress or white pine.	

   b. *Hardware.*

   ½ lb. 8d. common wire nails.

   ½ lb. 6d. common wire nails.

3. *Directions.*

   a. Dig a pit at least 22″ deep by 6′ 2″ long and 6′ wide. Dig it so that the 6′ 2″ distance runs east and west. This will make it possible to face the lowest side (the front) of the hotbed to the south. It may be well to dig the pit a little larger to make it easier to nail the sides and ends together. If the ground does not stand up well, drive 2″ × 4″ stakes at the corners, outside the hotbed, and nail the boards to these stakes.

   b. Put a bevel of 6″ in 6′ on two 1″ × 12″ side boards. Nail the sides so that they will project above the front 1⅜″ or a distance equal to the thickness of the sash. This makes the joints more air-tight than if the sash simply is laid on top of the frame.

   c. Nail the cross-bar in position with the upper edge (not including the parting stop) flush with the top of the front. Cut a notch 1″ deep × 3″ wide in the front piece to hold the cross-bar. At

the back side of the frame nail through the back instead of notching it for the cross-bar.

d. The guide strips on the sides and back are next nailed in place with 6d. common wire nails.

e. Place at least 18″ of fresh horse manure in the pit and about 4″ of soil above that. The manure should be well tramped down. For details refer to some of the references on hotbed construction found at the end of this chapter.

Hotbed (Portable, Knock-Down, Surface Type)

1. A hotbed of the portable, knock-down type is shown in Fig. 47. This hotbed was designed and built by the School of Agriculture of Purdue University. Fig. 47 shows a frame designed for four

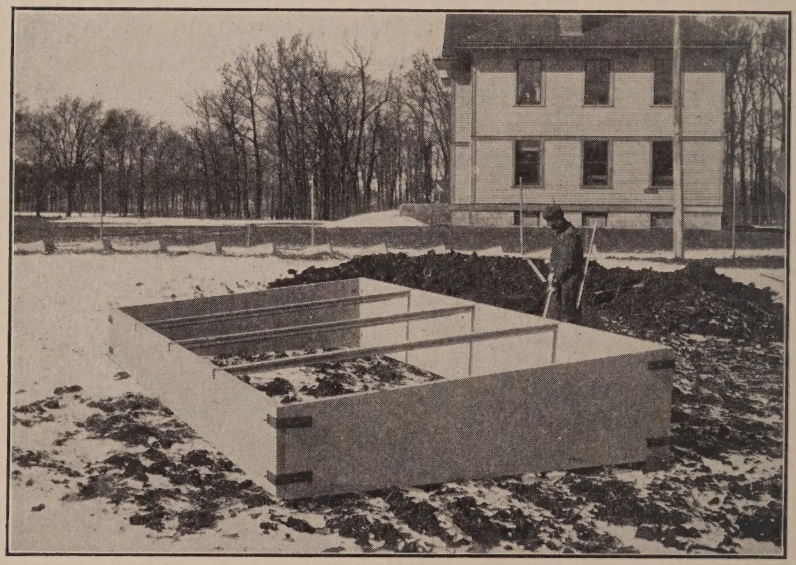


FIG. 47. FOUR-SASH HOTBED FRAME
Designed and built by the School of Agriculture, Purdue University.

standard (3′ × 6′) sash, while Fig. 48 shows the same type of hotbed half as large. The latter is large enough for a family garden.

Hotbeds of the surface type may be built as shown in Fig. 48. No pit is dug. The manure is tramped in a layer a couple of feet wider and larger than the hotbed frame, directly on the ground in a sheltered spot, and the frame is set over it. Manure is drawn around the frame to protect it from the weather.

Portable frames may be used to start cucumbers, parsley, melons, etc., and may be removed after the plants have grown quite large, as illustrated in Farmers' Bulletin No. 460 entitled "Frames as a Factor in Truck-Growing."

2. *Material required.*

No. of Pieces	Dimensions	Kind	Purpose
2	2″ × 16″ × 6′	Cypress	Sides
1	2″ × 10″ × 6′	Cypress	Front
1	2″ × 16″ × 6′	Cypress	Back
1	2″ × 3″ × 6′	Cypress	Cross-bar

b. *Hardware.*

1 lb. 16d. common wire nails.

2 pair steel strap hinges, 8″ long with screws.

2 pair steel crate hasps 6″ long with screws.

Note. Instead of hinges, steel straps may be made as fasteners for the corners as shown in Fig. 47. The hinges and hinge hasps are more easily obtained and are quicker to adjust.

3. *Directions.* The construction of the frame presents no problem not explained in the preceding project.

Place two strap hinges on each of two diagonally opposite corners and hinge hasps, crate hasps, or other fasteners on the other two corners. In this way only two corners need to be adjusted when placing or removing the frame. Place the hinges or hasps on the outside of the corners in such a way that the two adjacent sides may be folded together for storage.

For more details see Circular No. 77, 1918, entitled "Hot-beds for Home Gardens," Agricultural Experiment Station, Purdue University.

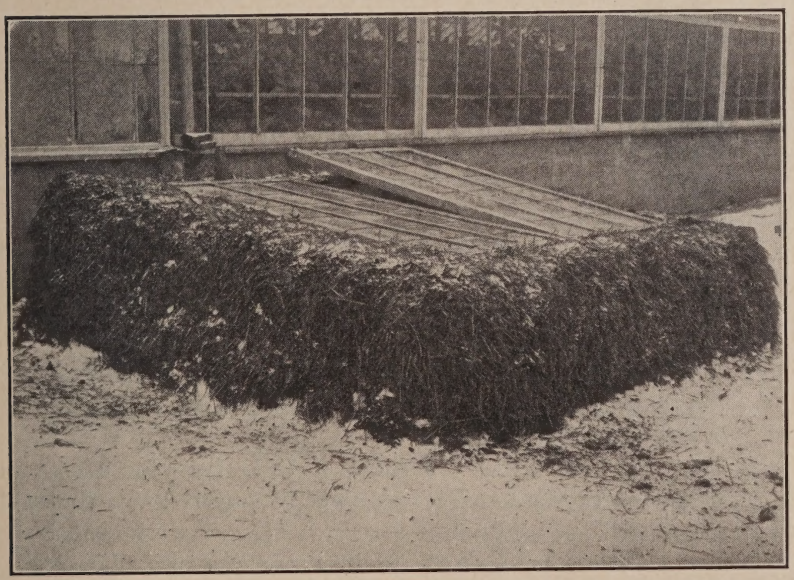


Fig. 48. Two-Sash Hotbed

Built by the School of Agriculture, Purdue University.

Hotbed (Permanent, Concrete Walls)

1. Often a hotbed is located in a certain sheltered place on the farm, or near the garden, and the same place will want to be used for years. Then it will pay to build the hotbed of stone, brick, or concrete.

   Concrete lends itself so well to the purpose that a list is given herewith of the materials required for the concrete hotbed illustrated in Fig. 49.

2. *Material required.*

   a. *Concrete.*

      Mixture of 1 part cement.
      2½ parts sand.
      4 parts pebbles or stone.

   b. *Quantities required.*

      7 sacks of cement.
      17.5 cu. ft. sand.
      28 cu. ft. pebbles or crushed stone.

   c. *Hardware.* 1 "T" bar 2″ wide, 6′ long.

   d. *Sash.* Two 3′ × 6′ hotbed sash.

3. *Directions.*

   a. Stake out a pit 6′ 10″ × 6′ 10″.

   b. Dig the pit 22″ deep. Where concrete walls are to be placed, dig 24″ deep.

   c. Erect forms similar to those shown in Fig. 192, with the exception that the form is used only on the inside below the ground level. This is because the earth may be spaded off in a vertical surface so as to make a form on the outside necessary only above the ground line.

   d. The forms should be constructed of surfaced lumber, and should be water-tight. Fasten the form by means of stakes and braces as illustrated in Fig. 192.

   e. Mix the cement as has been explained under "Hand-mixing concrete," Chapter III. If the weather is sunny, sprinkle the "green" concrete occasionally and keep it shaded with boards, sacks, or tar-paper.

   f. After the walls are self-sustaining, remove the forms and finish the parts exposed to view by giving them a cement-water wash or else a floated surface.

   g. Place the steel T bar in position so as to form the supporting cross-tie for the sash. This may well be done before the concrete is poured.

4. *Cement-water wash.* This is usually made of 1 part of cement, 1 part of clean fine sand, and sufficient water to make a paint.

   This wash is applied to the concrete surface, immediately after

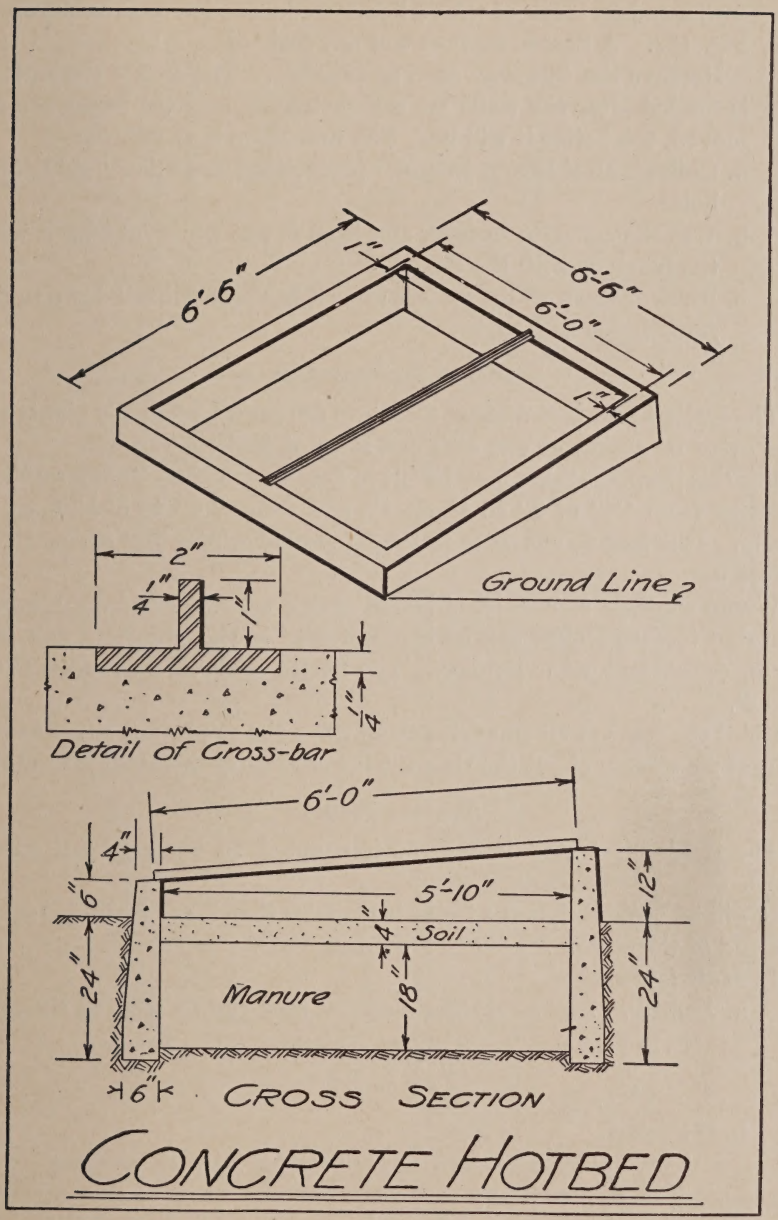


FIG. 49. CONCRETE HOTBED

the forms are removed, with a whitewash brush. Such painting fills up the pores and covers irregularities, but it has the disadvantage that it is likely to hair-crack and check, and may scale off.

5. *Floated finish.* A better finish than the one produced by the cement-water wash may be obtained by floating the surface with a

carborundum block or with a home-made wooden float as shown in Fig. 187. A floated surface will not scale off.

Remove the forms as soon as possible. The sooner the surface is floated after the walls are self-sustaining and the forms are removed, the better it will be. The procedure is as follows:

a. Chip off all ridges or irregular projections and fill or "point-up" holes.

b. Wet the concrete surface, and keep it wet while rubbing it with the block or with the float.

c. Rinse or wash off the surface after it has been rubbed down to the smoothness desired.

Stakes for Tomatoes

The earliest and best formed tomatoes are grown when the plants are supported on stakes or else on some form of trellis.

For this purpose stakes may be cut in near-by woods. Young saplings tapering from 1½″ or 2″ to about 1″, and from 4′ 6″ to 6′ long, serve nicely. It is best to cut them in the late fall or winter and season them before use.

Where saplings cannot be obtained stakes may be cut from lumber. Durable tomato stakes can be made of 1¾″ × 1¾″ chestnut, oak, cypress, cedar, and other lumber. The length may vary between 4′ 6″ and 6′.

Point the stakes well and drive them when the soil is wet, either at the time of planting or about the time the first cluster of tomatoes is forming.

Tomato Trellis

The trellis illustrated in Fig. 50 is adapted to home-garden conditions.

It will be noticed that the trellis is made so that it can be folded up at the end of the season for use in following years.

1. *Material required.*

a. *Lumber.* Box or crating material that can be secured cheaply.

No. of Pieces	Dimensions	Purpose
6	1″ × 2″ × 3′	Legs
8	1″ × 2″ × 6′	Slats

b. *Hardware.*

Three machine or carriage bolts ¼″ × 2″ with washers.
4′ of wire or heavy cord.
¼ lb. 6d. common wire nails.

2. *Directions.*

a. Select fairly strong pieces about 1″ × 2″ × 3′ for the legs. Cut a 45-degree cut on one end, and a square cut on the opposite end of each leg. A 45-degree cut is marked off with a steel square by holding equal distances on the blade and the tongue as illustrated in Fig. 197.

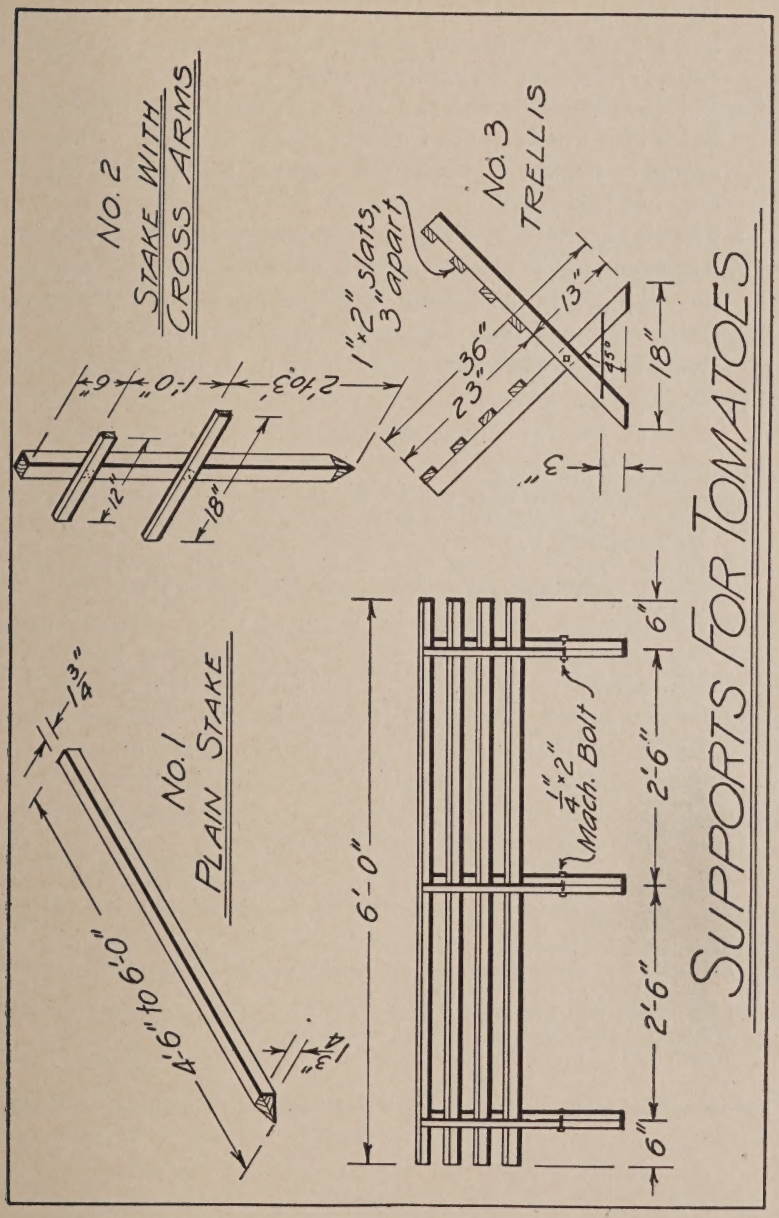


Fig. 50. Supports for Tomatoes

b. Lay each pair of legs together as shown in the end view, Fig. 50, and bore holes for the bolt that is to hold them together.

c. Before bolting the parts together, nail on the slats on each set of legs, being sure that the legs are spaced so that they can be bolted together.

d. The slats may vary in width, and in spacing, and each pair of

legs may be spaced at various distances apart, depending upon how far apart the tomato plants stand in the row, and upon the nature and size of the lumber available.

e. Holes are bored about 3″ above the ground line for wire or heavy twine that will keep the trellis in proper position. These holes should be bored near the outside edges of the pieces so that they may not tear out.

f. The plants are trained through the middle opening in the trellis.

g. At the end of the season, before frosts come, the vines are cut off near the ground and hung upside down in the attic or other suitable place so that the green fruit may gradually ripen. The trellis is telescoped and stored away in a dry place for future use.

REFERENCES

1. *A Selected list of free bulletins.*[1]
   a. *City Home Garden, The.* Beattie, W. R. Farmers' Bulletin 1044. 1919.
   b. *Control of Diseases and Insect Enemies of the Home Garden.* Orton, W. A., and Chittenden, F. H. Farmers' Bulletin 856. 1917.
   c. *Family Vegetable Garden, The.* Bechtel, John R. Extension Circular No. 76, 1919. Agricultural Experiment Station, The Pennsylvania State College.
   d. *Farm Garden in the North, The.* Beattie, James H. Farmers' Bulletin 937. 1918.
   e. *Frames as a Factor in Truck-Growing.* Beattie, W. R. Farmers' Bulletin 460. 1911.
   f. *Germination Test of Seed Corn.* Schmitz, Nickolas. Extension Circular, Agricultural Experiment Station. The Pennsylvania State College.
   g. *Handbook of Plant Disease and Pest Control.* Smith, R. E.; Essig, E. O.; and Gray, George P. Circular No. 204, 1918. Agricultural Experiment Station, University of California.
   h. *Hot-Beds for Home Gardens.* Lommel, W. E. Circular No. 77, 1918. Agricultural Experiment Station, Purdue University.
   i. *Hot-Bed Construction.* Sprague, C. B. Popular Bulletin No. 98, 1916. Agricultural Experiment Station, Pullman, Washington.
   j. *Striped Cucumber Beetle and its Control.* Chittenden, F. H. Farmers' Bulletin 1038. 1919.
2. *Text and reference books.*
   Bailey, L. H. *Principles of Vegetable Gardening.* Macmillan Co. (In preparation.)
   Lloyd, John W. *Productive Vegetable Growing.* J. B. Lippincott Co., 1918.
   Watts, R. L. *Vegetable Gardening.* Macmillan Co., 1912.
   Watts, R. L. *Vegetable Growing Projects.* Macmillan Co., 1922.

[1] For addresses of publishers and of Agricultural Experiment Stations, see Appendix.

CHAPTER VI

RELATING TO POULTRY HUSBANDRY

POULTRY husbandry is being carried on in most parts of the civilized world. Most eggs produced in the United States are produced as a "side-line," either on the farm where animal or crop production is depended upon for the major part of the income, or in urban communities where poultry husbandry is an avocation with large numbers of persons.

Many persons do not get as good returns as they should from their flocks because of poor housing facilities, and because of lack of suitable poultry-house conveniences. The subject-matter in this chapter is selected with a view to being helpful to those who wish to do construction or repair work in connection with poultry husbandry.

Egg-Tester (to be used with kerosene lamp)

1. *Purpose.* An egg-tester, or an egg-candler as it is sometimes called, may be made in a number of ways. The type of construction is governed by the kind of light that is used. Sunlight, the kerosene flame, and electric light are all used. As sunlight is not always available, artificial light is usually provided. Fig. 51 shows an egg-tester made for use with a common kerosene lamp. Notice that the chimney projects out of the box, and that air-holes must be provided in the bottom of the box so that the lamp will burn properly.

   The egg is held before the opening, the room being dark, and is examined for infertility, blood-ring, etc. By means of the light back of the egg, one is able to detect imperfections.

   It is best to test all eggs that are to be used for food, and it is likewise best to examine eggs for hatching, before and during the period of incubation.

2. *Material required.*

   a. *Lumber.* Box or crating materials.

No. of Pieces	Dimensions	Purpose
1	$\frac{1}{2}'' \times 3\frac{3}{4}'' \times 7\frac{3}{8}''$	Front
1	$\frac{1}{2}'' \times 7\frac{3}{8}'' \times 11''$	Lid
1	$\frac{1}{2}'' \times 5\frac{3}{4}'' \times 6\frac{3}{8}''$	Top
2	$\frac{1}{2}'' \times 9\frac{3}{4}'' \times 12''$	Sides
1	$\frac{1}{2}'' \times 7\frac{3}{8}'' \times 9\frac{3}{4}''$	Bottom
2	$1'' \times 1'' \times 9\frac{3}{4}''$	Cleats

   b. *Hardware.*

   2 small strap hinges, or
   2 leather hinges.

A few 3d. brads or nails.
A kerosene lamp.
A small piece of felt.

3. *Directions.*
   a. The dimensions given in the drawing are merely suggestive. Make the tester so that it will fit the kerosene lamp that is available for it.
   b. Nail the sides to the bottom piece after holes have been bored in the latter for air.
   c. Nail back in place, and fit front piece so that the upper edge will be beveled to fit the lid.
   d. Fit the top piece in place. Cut a hole for the chimney a little larger than the diameter of the chimney at this point in order that the lamp may be raised so that the lamp may be taken out through the door of the tester.
   e. Line the peep-hole in the lid with felt or similar material. This makes it possible to fit the eggs tightly against the opening without danger of breaking the eggs.
   f. The cleats are nailed under the bottom to allow the air to enter the tester freely.

Egg-Tester (to be used with electric light)

1. *Description.* This tester is adapted for use with electric light. Notice that the bulb which is attached to a drop-cord is easily placed in and out of the tester by raising the lid. The drop-cord fits into a notch in the top cover, which is open on the front edge.
2. *Material required.*
   a. *Lumber.* Box or crating material.

No. of Pieces	Dimensions	Purpose
1	$\frac{1}{2}'' \times 3\frac{3}{4}'' \times 7\frac{3}{4}''$	Front
1	$\frac{1}{2}'' \times 7\frac{3}{4}'' \times 9\frac{1}{2}''$	Lid
1	$\frac{1}{2}'' \times 4\frac{3}{4}'' \times 7\frac{3}{4}''$	Top
2	$\frac{1}{2}'' \times 8\frac{3}{4}'' \times 10''$	Sides
1	$\frac{1}{2}'' \times 7\frac{3}{4}'' \times 10''$	Back
1	$\frac{1}{2}'' \times 7\frac{3}{4}'' \times 8\frac{3}{4}''$	Bottom

   b. *Hardware.*
      2 small strap hinges, or
      2 leather hinges.
      A few 3d. brads or nails.
      A small piece of felt.
      An electric bulb on a drop-cord.
3. *Directions.* The method of construction is so similar to that for the egg-tester previously explained that further directions are unnecessary. It will be noticed that the hinges are located at the lower edge of the lid, and air holes are not necessary in the bottom of this tester.

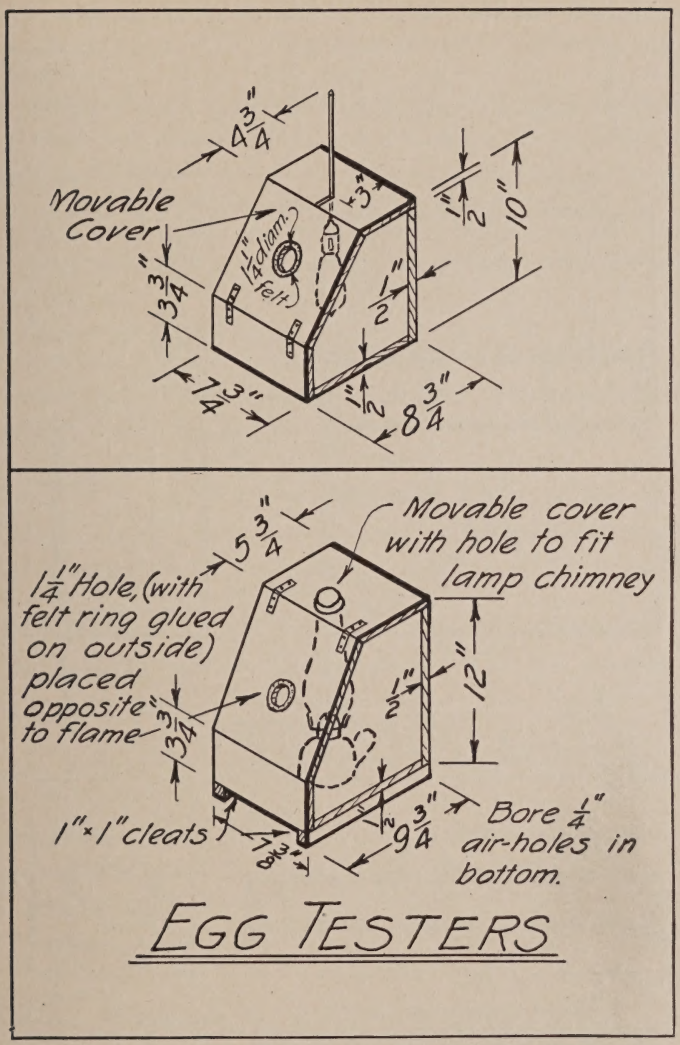


FIG. 51. EGG-TESTERS

Feed Trough (Open Type)

1. *Purpose.* Troughs of several kinds are used for feeding wet mash, and other forms of wet food that cannot well be strewn about the yard or in the litter.

   These troughs can be made in various lengths and shapes to suit special requirements. They are usually made of lumber, but sometimes sheet iron and cast iron are also employed.

   The open type feed trough illustrated in the drawing is easy to make but has the disadvantage that it is difficult to keep clean.

2. *Material required* (for a trough 6′ long).

a. *Lumber.* Yellow pine, chestnut, cypress, cedar, etc.

No. of Pieces	Dimensions	Purpose
1	$13/16'' \times 5\frac{3}{4}'' \times 6'$	Side
1	$13/16'' \times 4\frac{15}{16}'' \times 6'$	Side
2	$13/16'' \times 5\frac{3}{4}'' \times 13\frac{1}{2}''$	Ends
1	$13/16'' \times 2'' \times 10''$	Cleat

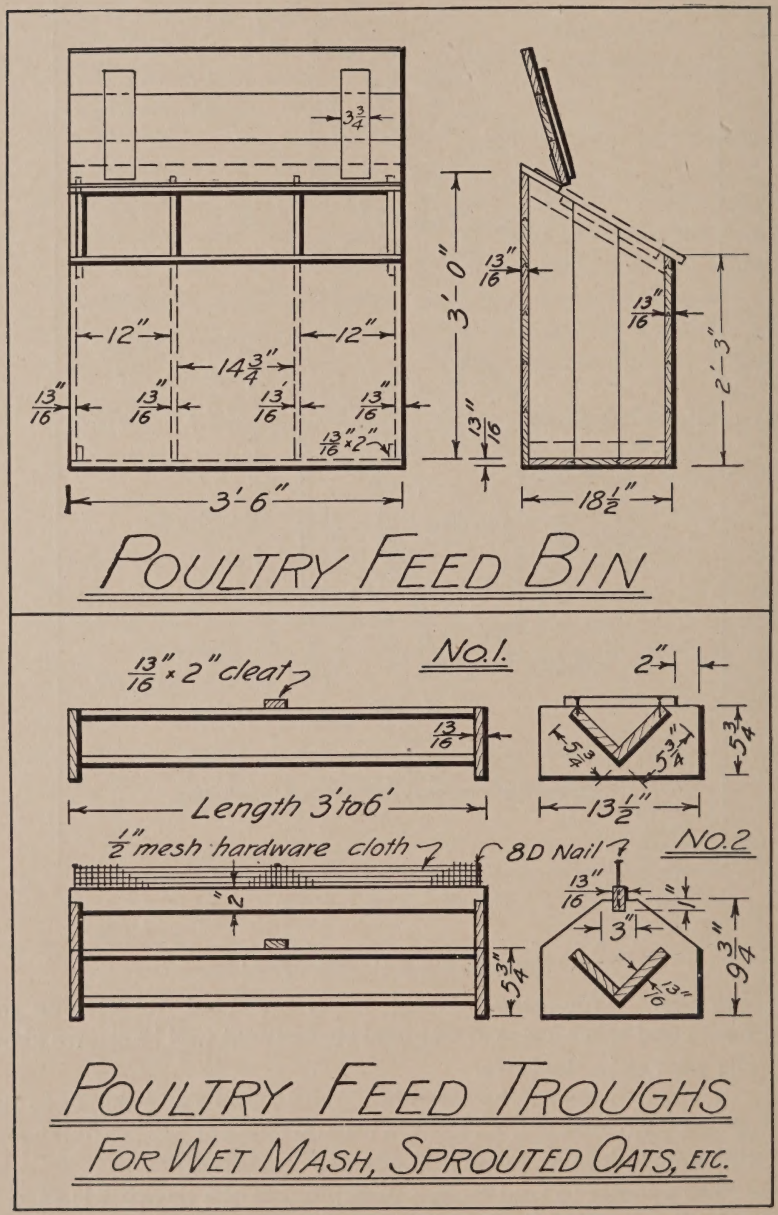


Fig. 52. Poultry Feed Bin. Poultry Feed Troughs for Wet Mash, Sprouted Oats, etc.

b. *Hardware.* Two or three dozen 8d. common wire nails or the same number of 1¾″ No. 10 flat head bright screws.

3. *Directions.*

a. Joint the edges of the two pieces that are to form the sides of the trough, and fasten them together, using nails or screws set from 4″ to 6″ apart.

b. Cut out the pieces. Plane them smooth and flat and nail or screw them to the sides of the trough in such a way that the sides do not touch the ground, as this would cause them to decay more quickly.

c. Fasten the cross-cleat in place.

d. It is well to give feed troughs two coats of linseed oil, inside and outside. Let each coat dry thoroughly before applying the next one. Apply the oil with cotton waste or with a rag.

Feed Trough (Protected Type)

1. *Purpose.* This trough serves the same purpose as the one described under paragraph C.

2. *Material required* (for trough 6′ long).

a. *Lumber.*

No. of Pieces	Dimensions	Purpose
1	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 6'$	Side
1	$1\frac{3}{16}'' \times 4\frac{15}{16}'' \times 6'$	Side
2	$1\frac{3}{16}'' \times 9\frac{3}{4}'' \times 13\frac{1}{2}''$	Ends
1	$1\frac{3}{16}'' \times 2'' \times 10''$	Cleat
1	$1\frac{3}{16}'' \times 2'' \times 6'$	Guard rail

b. *Hardware.* Two or three dozen 8d. common wire nails, or the same number of 1¾″ No. 10, flat head bright screws. 1 piece hardware cloth 2″ wide by 6′ long, or else a piece of sheet metal or tin, 2½″ wide by 6′ long, with sufficient tacks or shingle nails to fasten the same.

3. *Directions.*

a. The method of construction is almost identical with that of the open type trough that has already been explained, with the exception of the guard rail which is added in this case. After fastening together the sides, put on the ends, and then the cross-cleat.

b. Next fasten the lengthwise guard rail in position, placing it as shown in the drawing, or so that poultry will not try to get under it.

c. To keep poultry from flying and roosting on this rail, fasten a narrow strip of hardware cloth on it by means of 8d. common wire nails. This hardware cloth should be cut so as to leave a ragged edge on its top edge.

d. If hardware cloth (square mesh wire having 3 or 4 wires per inch) is not available, use tin or sheet metal which is cut saw-

tooth fashion like the knives on a mowing machine, and which can be nailed on the top guard rail.

Poultry Feed Bin

1. *Purpose.* A feed bin having several partitions and a sloping top so that poultry will not roost on it is very desirable. The bin should have several parts for dry mash and one or more varieties of scratch feed.
2. *Material required.*
   a. *Lumber.* Usually box or crating material can be secured at slight expense. Perhaps a box can be found that can be worked into a feed box as shown with little effort and expense.

No. of Pieces	Dimensions	Purpose
5	$13/16'' \times 5\frac{3}{4}'' \times 3'\ 6''$	Front
6	$13/16'' \times 5\frac{3}{4}'' \times 3'\ 6''$	Back
6	$13/16'' \times 5\frac{3}{4}'' \times 3'$ (2′ 3″ to 3′)	Sides
3	$13/16'' \times 5\frac{3}{4}'' \times 3'\ 6''$	Bottom
10 sq. ft.	$\frac{1}{2}''$ or $13/16''$	Material for partitions
2	$13/16'' \times 3\frac{3}{4}'' \times 1'\ 4''$	Cleats for cover
2	$13/16'' \times 2'' \times 20''$	Cleats for sides (top)
2	$13/16'' \times 2'' \times 17''$	Cleats for sides (bottom)

   b. *Hardware.*

   1½ lbs. 8d. common wire nails.
   ½ lb. 6d. common wire nails.
   1 pr. 6″ strap hinges with screws.
   1 6″ wrought steel hinge hasp with screws.

Mash-Hopper for Chicks

1. *Purpose.* Young chicks can be fed either dry or wet mash, as well as small scratch feed in shallow trays or hoppers such as shown in the drawing. These trays are made in lengths that are conveniently handled.

   If the mother hen is with the chicks in order to keep her from wasting feed by scratching it out of the trays it is well to place a piece of hardware cloth or a piece of 1″ mesh chicken wire over the feed.

   It will be noticed that the two trays shown are approximately the same size. The chief difference is that one is made of wood while the other is of sheet metal with only the end pieces of wood. The trays could also be made entirely of sheet metal.
2. *Material required.*
   a. For tray No. 1 (made of lumber).
   Lumber. Box or crating material.

No. of Pieces	Dimensions	Purpose
2	$\frac{1}{2}'' \times 2'' \times 2'$	Sides
1	$\frac{1}{2}'' \times 5'' \times 2'$	Bottom
2	$13/16'' \times 2'' \times 5''$	Ends

Hardware.

About 30 3d. or 4d. common wire nails.

1 piece hardware cloth 6″ × 24″ or a piece 1″ mesh poultry wire 6″ × 24″, galvanized.

1 piece No. 8 (Brown Sharpe Gauge) wire 5′ long (this is about ⅛″ in diameter).

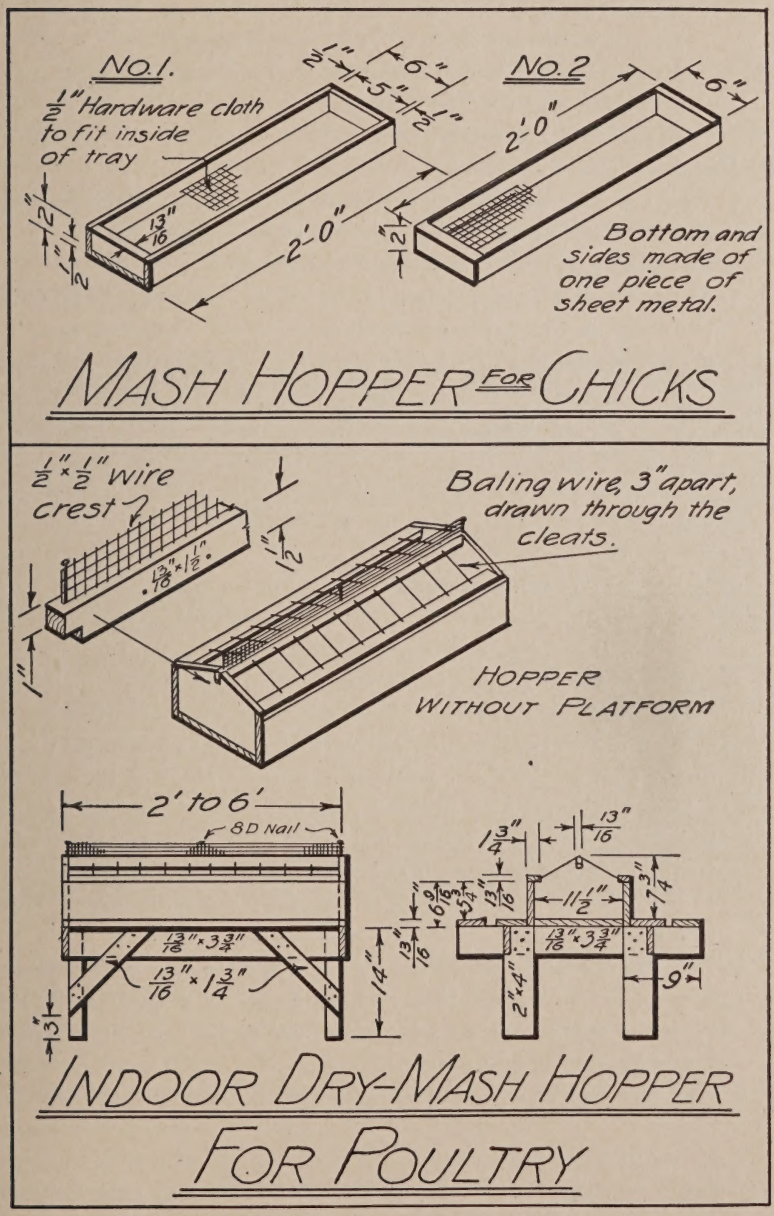


FIG. 53. MASH HOPPER FOR CHICKS. INDOOR DRY-MASH HOPPER FOR POULTRY

b. For tray No. 2 (sheet metal with wooden ends).
Lumber. Box or crating material.

No. of Pieces	Dimensions	Purpose
2	$13/16'' \times 2'' \times 6''$	Ends

Hardware.
1 piece tin or galvanized iron $11'' \times 2'$.
1 piece hardware cloth $6'' \times 24''$, galvanized.
1 piece No. 8 (Brown and Sharpe Gauge) wire 5′ long (this is about $1/8''$ in diameter).
About 14 3d. common wire nails.

3. *Directions* (for tray No. 1).
   a. Nail the tray together as shown in the drawing. The bottom is nailed to the end pieces before the sides are put on.
   b. Finish the tray with two coats of linseed oil.
   c. The piece of wire mentioned in the bill of material is to go around the edges of the hardware cloth so as to stiffen it, and keep it in shape. Bend the wire so that it will form a rectangle $5/8''$ shorter and $5/8''$ narrower than the inside dimensions of the tray.
   d. With a pair of pliers crimp the hardware cloth, or the netting, as the case may be, around the wire frame just mentioned. Use it with the smooth side up — that is, with the crimped edge on the under side so that small chicks may not hurt themselves on it.
   e. If the tray is made of good smooth lumber it will pay to give it two coats of boiled linseed oil. It is easier to keep the tray clean, and it will last longer if treated with linseed oil.
4. *Directions* (for tray No. 2).
   a. The piece of tin or galvanized iron that is to form the bottom and sides is folded in shape by laying the sheet on a bench so that $1/2''$ of the side of the sheet projects. Place a piece of $2'' \times 4'' \times 2'$ on top of it, and with another piece of $2'' \times 4''$ material about a foot long bend down the projecting edge until it is at right angles to the sheet, and forms a sharp crease at the point of bending. It may then be bent down flat against itself with ease. This is to stiffen the edge.
   b. Perform the same operation on the opposite side of the sheet.
   c. Bend the tin or sheet metal over a length of $2'' \times 4''$ or $2'' \times 6''$ material by the method explained under "a" to the shape required to fit the end pieces.
   d. Nail the sheet metal to the ends with shingle nails set about 1″ apart.
   e. If bright tin is used it should be painted on both sides with iron-oxide or Prince's metallic paint. Any kind of exterior house paint is better than none.

f. Galvanized iron is better than tin for the purpose. It need not be painted.

Indoor Dry-Mash Hopper for Poultry

1. *Purpose.* Dry-mash hoppers are extensively used by poultrymen. Dry mash of varying composition is kept before poultry at all times, either in indoor or outdoor hoppers.

The average dry-mash hopper is either wasteful, in that it permits the birds to waste some of the food, or it has a tendency to clog. The one illustrated in the drawing has been used successfully for several years at the Pennsylvania State College by the Poultry Department.

It will be noticed that the hopper is set on a platform about 15″ above the floor. This is done to prevent the birds from scratching litter into the hopper.

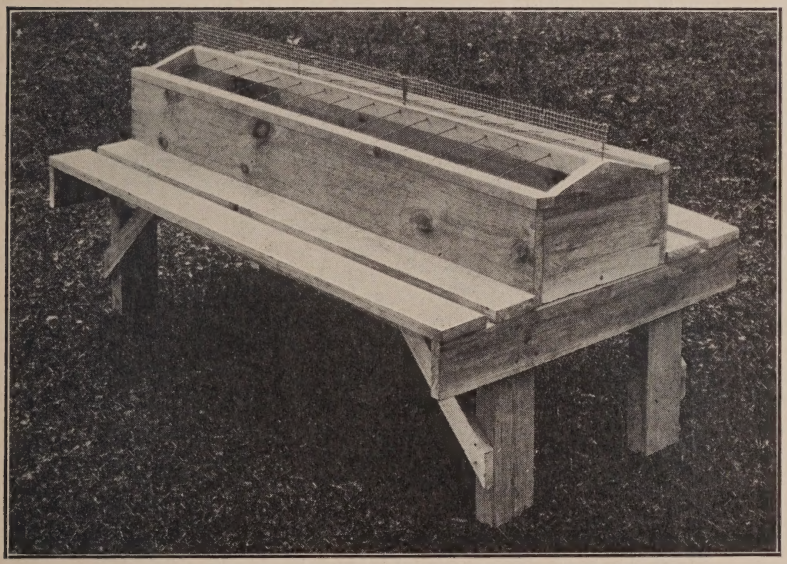


FIG. 54. DRY-MASH HOPPER

Built by students under the direction of Mr. W. G. Hall, at the Pennsylvania State College.

The hopper is a unit in itself, and is set on the stand, but not fastened thereto.

The wire guard running lengthwise of the hopper will effectively keep poultry from roosting on the hopper.

2. *Material required.*

a. *Lumber.* Many varieties of lumber can be used. Sometimes box or crating material will serve the purpose.

No. of Pieces	Dimensions	Purpose
1	$13/16'' \times 11\frac{1}{2}'' \times 4'$	Bottom
2	$13/16'' \times 5\frac{3}{4}'' \times 4'$	Sides
2	$13/16'' \times 7\frac{3}{4}'' \times 11\frac{1}{2}''$	Ends
	Hopper	
1	$13/16'' \times 1\frac{1}{2}'' \times 4'$	Top guard rail
2	$13/16'' \times 1\frac{3}{4}'' \times 4'$	Top pieces for sides
4	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 14''$	Legs
2	$13/16'' \times 3\frac{3}{4}'' \times 2'\ 5\frac{1}{2}''$	Cross-pieces
	Stand	
2	$13/16'' \times 3\frac{3}{4}'' \times 4'$	Stand side pieces
4	$13/16'' \times 1\frac{3}{4}'' \times 1'\ 3''$	Braces
4	$13/16'' \times 3\frac{3}{4}'' \times 4'$	Top board for stand

b. *Hardware.*

¾ lb. 8d. common wire nails.

½ lb. 6d. common wire nails.

1 piece hardware cloth $2'' \times 4'$.

18 lineal ft. of baling wire or any wire $1/16''$ to $1/8''$ in diameter.

3. *Directions* (for making the stand).

a. Cut a notch $13/16'' \times 3\frac{3}{4}''$ on one corner of each of the four legs. Use a rip-saw and a cross-cut saw for this purpose.

b. Nail the side pieces into these notches at right angles or square to the legs and fasten the braces to keep legs square to the sides.

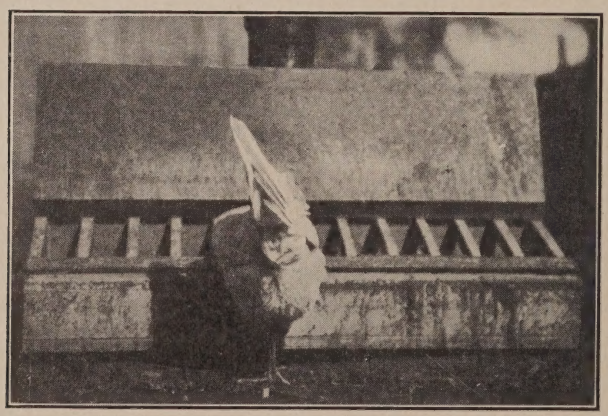


Fig. 55. Dry-Mash Hopper

Built by a boy attending the Honey Brook, Pa., Vocational School.

c. Fasten the cross-pieces to the legs. See to it that the inside edge of each leg is 9″ from the end of the cross-piece, and that the legs are nailed on square to the cross-piece.

d. The top boards of the stand should not be nailed fast until the hopper has been made. The latter should be placed on the stand and then the top boards may be nailed, allowing $1/8''$ space on both sides so that the hopper can be removed easily when it needs to be cleaned.

e. In selecting the top boards it will be well to choose lumber with

a vertical or comb grain as slash-grained lumber will not last as long in places that need to be cleaned frequently with a hoe or similar tool.

4. *Directions* (for making the hopper).
   a. Select a bottom board about 11½″ wide and cut the end boards exactly the same length as the bottom board is wide.
   b. Cut the end boards to the dimensions shown or to fit bottom and side boards that may be chosen.
   c. Cut the bevels on the end boards and notches 1 3/16″ wide by ¾″ deep at the top points to receive the ends of the top guard rail.
   d. Nail strips 1 3/16″ × 1¾″ × 4′ on the top edge of each side, and bore holes about ⅛″ in diameter and 3″ apart in these strips and in the top guard rail.
   e. Pass baling or other wire through these holes. Draw the wires taut and fasten the ends.
   f. The wire crest of hardware cloth or of tin cut to saw-tooth points is then fastened to the top guard rail running lengthwise of the hopper.
   g. Finish if desired with linseed oil, or with paint.
   h. Strips of wood about ½″ × ½″ can be used instead of the wires to keep the birds from raking out the feed by means of a sidewise movement of their heads.

Water Stand for Poultry

Purpose. It is not always an easy matter to provide clean water at

FIG. 56. WATER STAND FOR POULTRY
Designed and built at Purdue University.

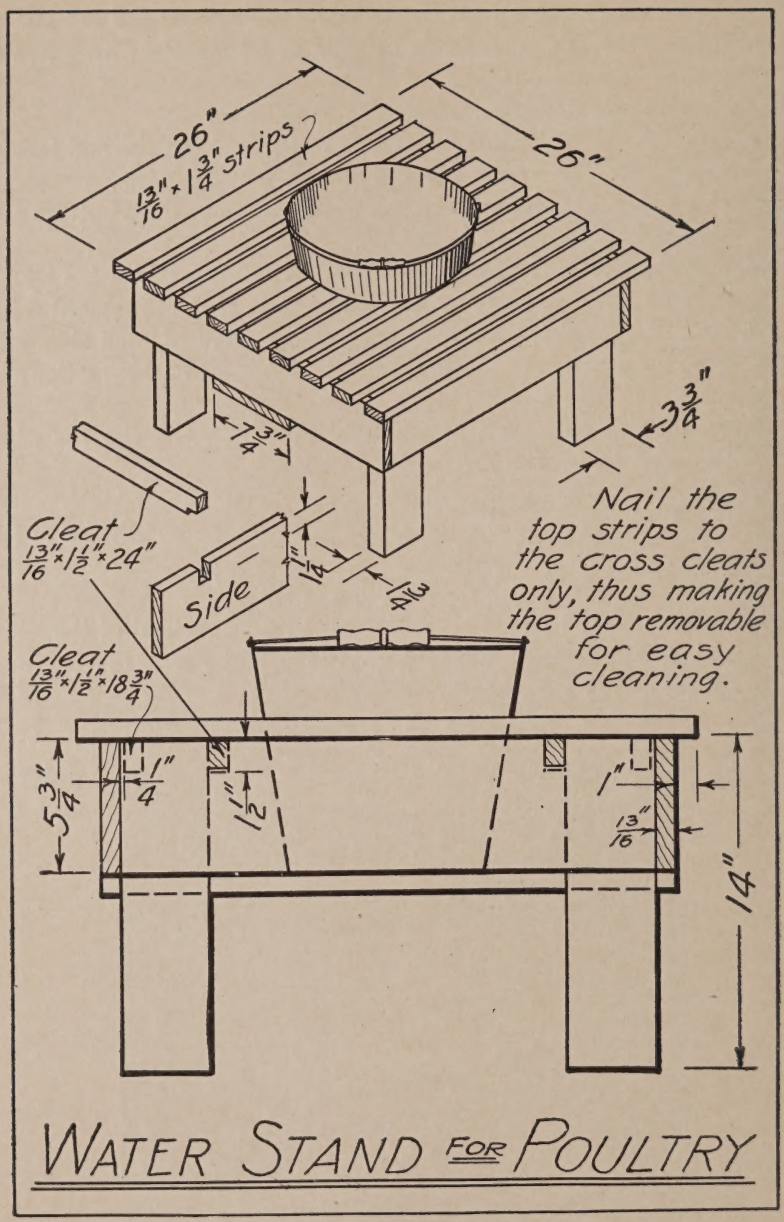


FIG. 57. WATER STAND FOR POULTRY

proper temperatures for poultry. This is especially true on farms where there is no running water or water-supply system. The water stand shown in Fig. 56 was built and photographed by the Poultry Department of Purdue University. The stand is made so that an ordinary water bucket can be used. The bucket is placed

in a stand so that it is easily reached and so that litter cannot be scratched into it. Water will keep cool longer in summer, and will resist freezing better in winter when it is kept in a deep vessel. Hence a bucket is better in these respects than a shallow pan.

2. *Material required.*

a. *Lumber.* Yellow pine, hemlock, spruce, and many other kinds. Box or crating material may be used.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 14''$	Legs
2	$1\frac{3}{16}'' \times 4\frac{3}{4}'' \times 24''$	Sides
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 22\frac{3}{8}''$	Ends
1	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 24''$	Board under pail
2	$1\frac{3}{16}'' \times 1\frac{1}{2}'' \times 24''$	Cleats
2	$1\frac{3}{16}'' \times 1\frac{1}{2}'' \times 20\frac{1}{4}''$	Cleats
9	$1\frac{3}{16}'' \times 1\frac{3}{4}'' \times 26''$	Strips

b. *Hardware.*

½ lb. 8d. common wire nails.

¼ lb. 6d. common wire nails.

1 10 or 12 qt. water pail.

3. *Directions.*

a. Nail the end pieces to the legs after having notched them as shown in the drawing for two of the $1\frac{3}{16}'' \times 1\frac{1}{2}''$ cleats. Use a square in assembling the job, making certain that the legs are square to the sides and the sides square to the ends.

b. Nail the side pieces in place, and turn the frame upside down in order to fasten the board upon which the bottom of the pail rests.

c. The top part of the stand is to be made removable, therefore nail the top strips to the cross-cleats only, and let the cleats fit rather loosely in the supporting notches.

The two inside cleats are 26″ long and run from outside to outside. The two outside cleats (those nearest the outer edges) are cut $20\frac{1}{4}''$ long so that they will fit loosely between the legs near the sides. The weight at this point is carried by the sides, not by the cleats.

d. With a nail-set drive the nails in the top strips slightly below the surface so that a hoe or other scraping tool used for cleaning the stand will not catch on the nail heads.

Oats Sprouter

1. *Purpose.* One of the best green feeds for poultry during the winter season, or when they do not have access to grass, is supplied by sprouting oats. Oats may be sprouted and allowed to grow until it is four to six inches high when it is fed to poultry. One square inch of the sprouted oats four or six inches high per day per bird is sufficient.

A convenient way to sprout oats is with the use of an oats

sprouter such as the one illustrated. The drawing shows the framework only. It is made to hold four standard size vegetable flats, the details of which are given in Fig. 34.

Oats are sprouted as follows: Pour a few quarts of good heavy feed oats in a pail containing as much water as the oats will absorb. To prevent mould, add one drop of formalin for each quart of water used. Let the oats soak in the pail in a warm room for forty-eight hours. Then pour the oats into the trays of the oats sprouter, spreading the oats 1″ thick. Keep the rack in a fairly warm room, and sprinkle the growing oats twice a day. It should be four to six inches high, and ready for use within a week after being placed.

2. *Material required.*

a. *Lumber.* Many kinds can be used. It need not be expensive. Box or crate material may be all right.

No. of Pieces	Dimensions	Purpose
4	13/16″ × 3¾″ × 31¾″	Legs
2	13/16″ × 3¾″ × 18⅝″	Base boards
2	13/16″ × 2″ × 15⅝″	Cross-ties
2	¼″ × 1¼″ × 2′ 7″	Braces
8	13/16″ × 1½″ × 16″	Guide strips
8	13/16″ × 1″ × 23½″	Guide strips

b. *Hardware.*

½ lb. 6d. common wire nails.

¼ lb. 8d. finishing or casing nails.

c. Flats. 4 standard size flats as described in Fig. 34.

3. *Directions.*

a. Nail together the 8 guide strips. Each of these strips is made of two pieces, one piece 23½″ long and one piece 16″ long. The pieces should be exact in length, and the short pieces should start and end 3¾″ from the ends of the long pieces. This is because the short pieces fit between the legs of the sprouter while the longer ones are nailed to the sides of the legs, and run from outside to outside of the legs.

b. Fasten the guide strips to the legs. Each pair of strips on opposite sides of the sprouter should be the same distance from the ground.

c. The two sides may next be connected at the top and at the bottom with the base boards and the top cross-pieces, all of which are 18⅝″ long.

d. Fasten the braces shown at the back of the sprouter in place. Square up the various parts during the process of construction, and check up before fastening the braces.

e. Screws may be used throughout instead of nails, but it is not necessary.

f. It is desirable to place castors under the sprouter so that it can be moved about easily.

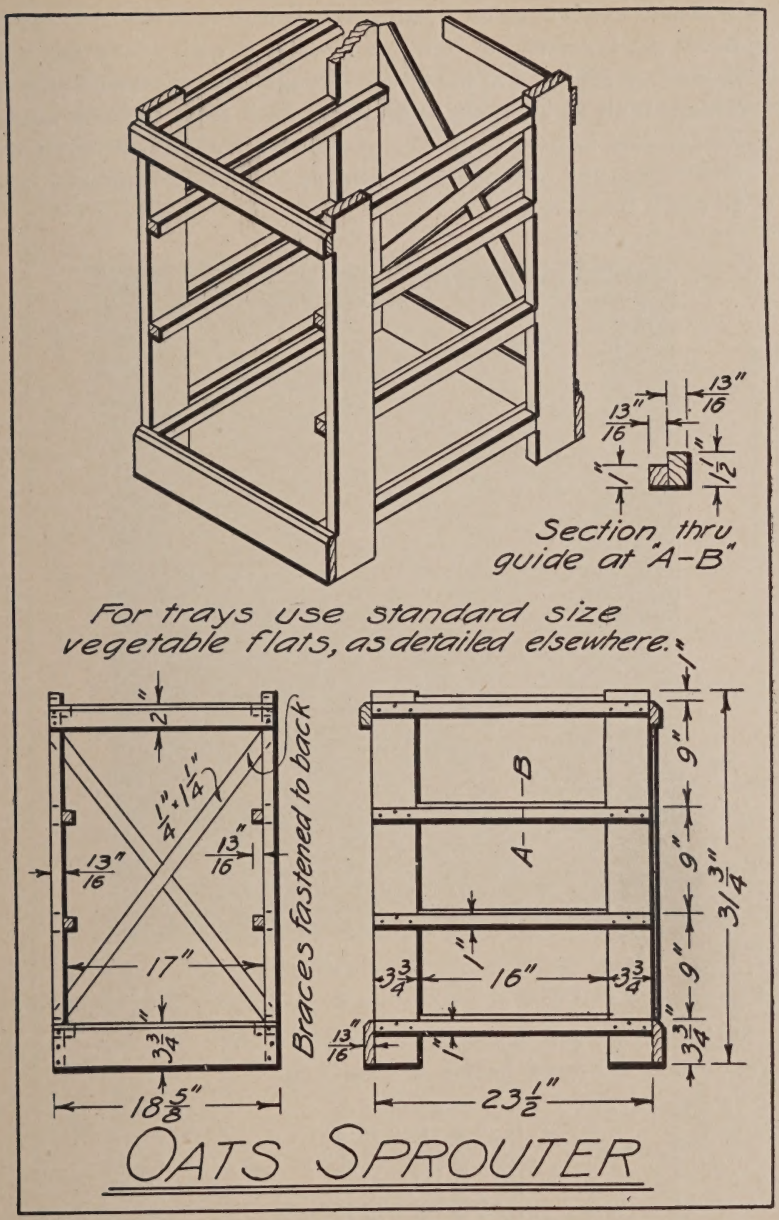


FIG. 58. OATS SPROUTER

Poultry Feeder (for Green Feed)

1. *Purpose.* In feeding lawn clippings, cut grass, or clover to poultry, difficulty is usually experienced in that the birds walk over and waste a good deal of this succulent food. In order to overcome this the feeder shown herewith has been designed.

The feeder is hung on a wall at a height so that the birds can just reach the lower end of it which is covered with wire mesh. The green food is placed in the feeder through a hinged door at the top. This is built at an angle to keep the birds from roosting upon it. The sloping bottom tends to make the contents of the feeder work downward, and also makes it possible for birds of different height to reach the food.

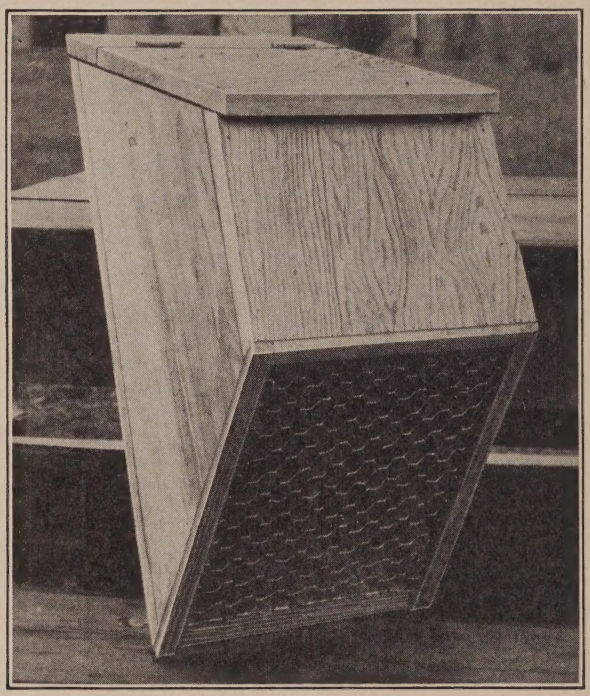


FIG. 59. POULTRY HOPPER FOR GREEN FEED

Made by students under the direction of Mr. W. G. Hall, at the Pennsylvania State College.

2. *Material required.*

a. *Lumber.* Box or crating material.

NO. OF PIECES	DIMENSIONS	PURPOSE
2	$^{13}/_{16}'' \times 11^{7}/_{8}'' \times 24''$	Sides
1	$^{13}/_{16}'' \times 11^{3}/_{4}'' \times 11''$	Front
1	$^{13}/_{16}'' \times 11^{3}/_{4}'' \times 24''$	Back
1	$^{13}/_{16}'' \times 3^{3}/_{4}'' \times 12^{1}/_{2}''$	Top
1	$^{13}/_{16}'' \times 11^{1}/_{2}'' \times 12^{1}/_{2}''$	Top

b. *Hardware.*

1 piece wire screen $12^{1}/_{2}'' \times 15''$.

1 pr. butt hinges 2″ wide, with screws.

About 2 doz. 8d. finishing nails.

About 2 doz. $^{1}/_{2}''$ poultry netting staples.

3. *Directions.* The construction is so simple that few special directions are necessary.

a. Fasten hinges to the two parts before nailing the narrow part fast. T hinges may also be used, or simply pieces of leather.
b. Fasten the netting with ½″ or with ⅝″ poultry netting staples.
c. Note how the boards are lapped in order to use standard width lumber without sawing.

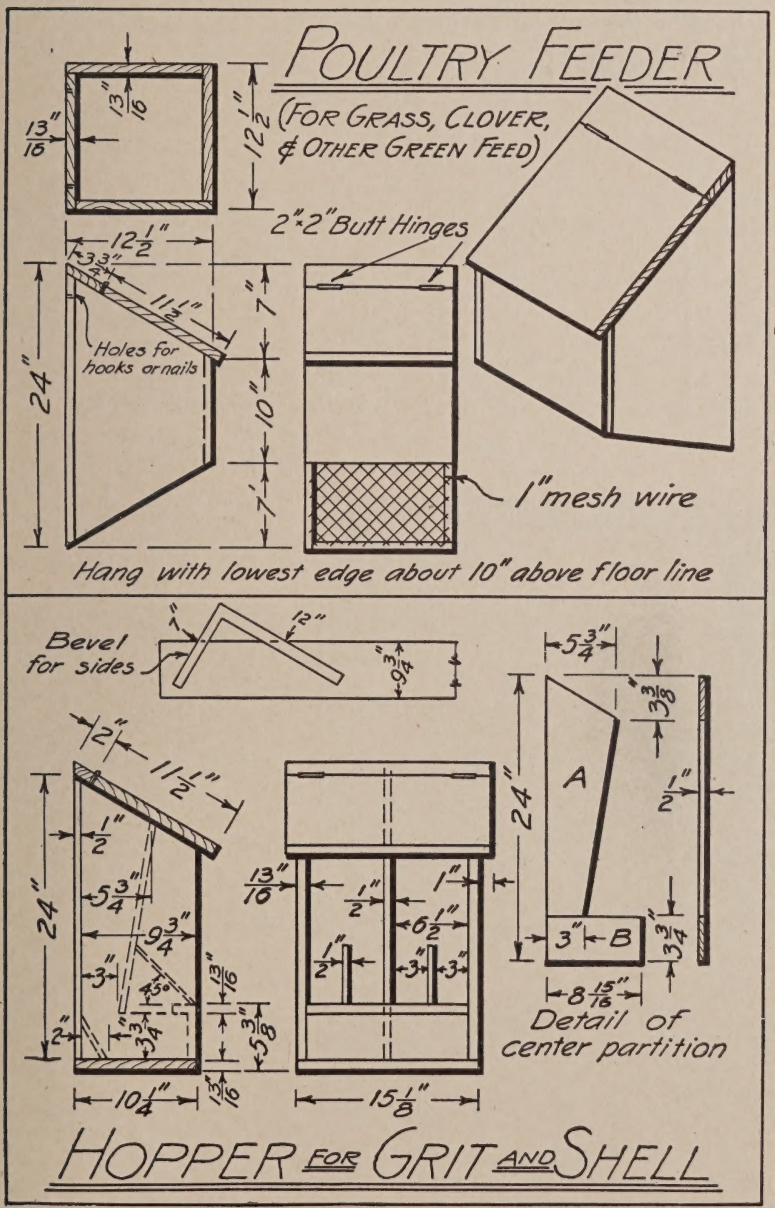

POULTRY FEEDER
(FOR GRASS, CLOVER, & OTHER GREEN FEED)
2"×2" Butt Hinges
Holes for hooks or nails
1" mesh wire
Hang with lowest edge about 10" above floor line
Bevel for sides
Detail of center partition
HOPPER FOR GRIT AND SHELL

FIG. 60. POULTRY FEEDER. HOPPER FOR GRIT AND SHELL

Hopper for Grit and Shell

1. *Purpose.* Grit and shell hoppers are used so that these materials can be kept before poultry all of the time in containers that require little attention, and that keep the grit and shell from being wasted.

The hopper shown may sit on the ground out of doors or can be hung on the wall inside the poultry house.

2. *Material required.*

a. *Lumber.* White pine, cypress, cedar, etc.

No. of Pieces	Dimensions	Purpose
2	$\frac{13}{16}'' \times 9\frac{3}{4}'' \times 24''$	Sides
1	$\frac{1}{2}'' \times 5\frac{3}{4}'' \times 24''$	Partition (cross-wise)
1	$\frac{1}{2}'' \times 3\frac{3}{4}'' \times 8\frac{15}{16}''$	Partition (cross-wise)
1	$\frac{13}{16}'' \times 10\frac{1}{4}'' \times 15\frac{1}{8}''$	Bottom
1	$\frac{13}{16}'' \times 2'' \times 17\frac{1}{8}''$	Top
1	$\frac{13}{16}'' \times 11\frac{1}{2}'' \times 17\frac{1}{8}''$	Top
2	$\frac{1}{2}'' \times 7\frac{9}{16}'' \times 24''$	Back
1	$\frac{1}{2}'' \times 13\frac{1}{2}'' \times 16''$	Partition (length-wise)
2	$\frac{1}{2}'' \times 3\frac{3}{4}'' \times 6\frac{1}{2}''$	Baffle board
1	$\frac{13}{16}'' \times 3\frac{3}{4}'' \times 13\frac{1}{2}''$	Front
1	$\frac{13}{16}'' \times 2'' \times 13\frac{1}{2}''$	Front
2	$\frac{1}{2}'' \times \frac{1}{2}'' \times 7''$	Division bars

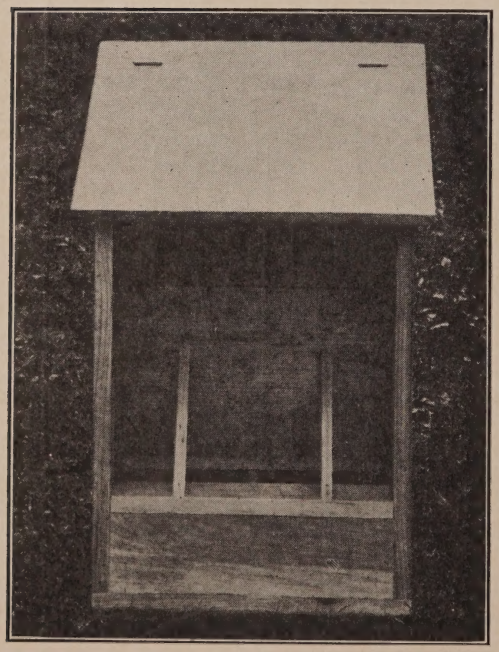


Fig. 61. Grit Hopper
Built by students under the direction of Mr. W. G. Hall, at the Pennsylvania State College.

b. *Hardware.*

1 pair butt hinges $2\frac{1}{2}''$, narrow,
or 1 pair 3 or 4″ T hinges with screws,
or else leather hinges.
¼ lb. 3 or 4d. nails, or brads,
⅛ lb. 6d. finishing, or casing nails.

3. *Directions.*

a. Cut a 7 to 12 bevel on the side-pieces and on the partition that runs crosswise. Place the square for the bevels as shown in the drawing.

b. Nail the bottom and the sides together first, then fasten the back to the sides and bottom.

c. Fasten the front board

in place but leave the $1\frac{3}{16} \times 2''$ strip off the top of this board until the partitions are in place.

d. Cut out the partition running crosswise as shown in the detail drawing and nail it in place.

e. Nail the two small, sloping baffle boards in place that go in the lower back corners of the hopper. Their purpose is to throw the grit or shell toward the front of the hopper.

f. Cut the partition that runs lengthwise according to the dimensions given and nail it in place.

g. Finish the lower part of the front of the hopper by nailing the $1\frac{3}{16}'' \times 2''$ strip on the front piece and the $\frac{1}{2}'' \times \frac{1}{2}''$ division bars in place. Wire can be used in place of the wooden division bars.

h. Hinge the two parts of the top together before nailing the upper part of the top in place.

i. Paint the hopper if desired with two coats of good exterior paint.

Out-door Dry-Mash Hopper

1. *Purpose.* Out-door dry-mash hoppers are frequently used. One of the greatest difficulties arises from the fact that rain may get into them and dampen the mash so that it may spoil, and it sometimes clogs in the hopper so that the birds cannot get at it.

The hopper illustrated in Fig. 62 and in the working drawing shown was made for young chicks. Place the hopper with the closed side toward the prevailing storms.

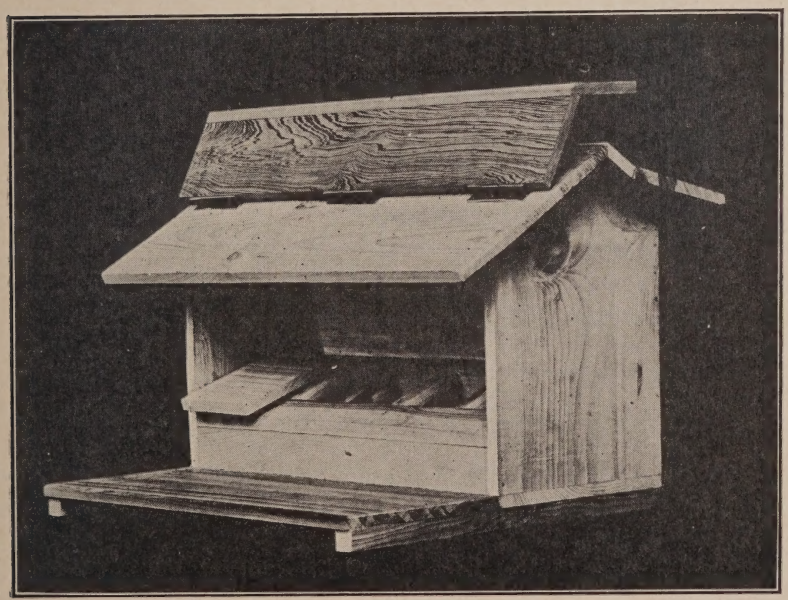


FIG. 62. PORTABLE OUT-DOOR FEED HOPPER FOR SMALL CHICKS IN LOW RUNWAY

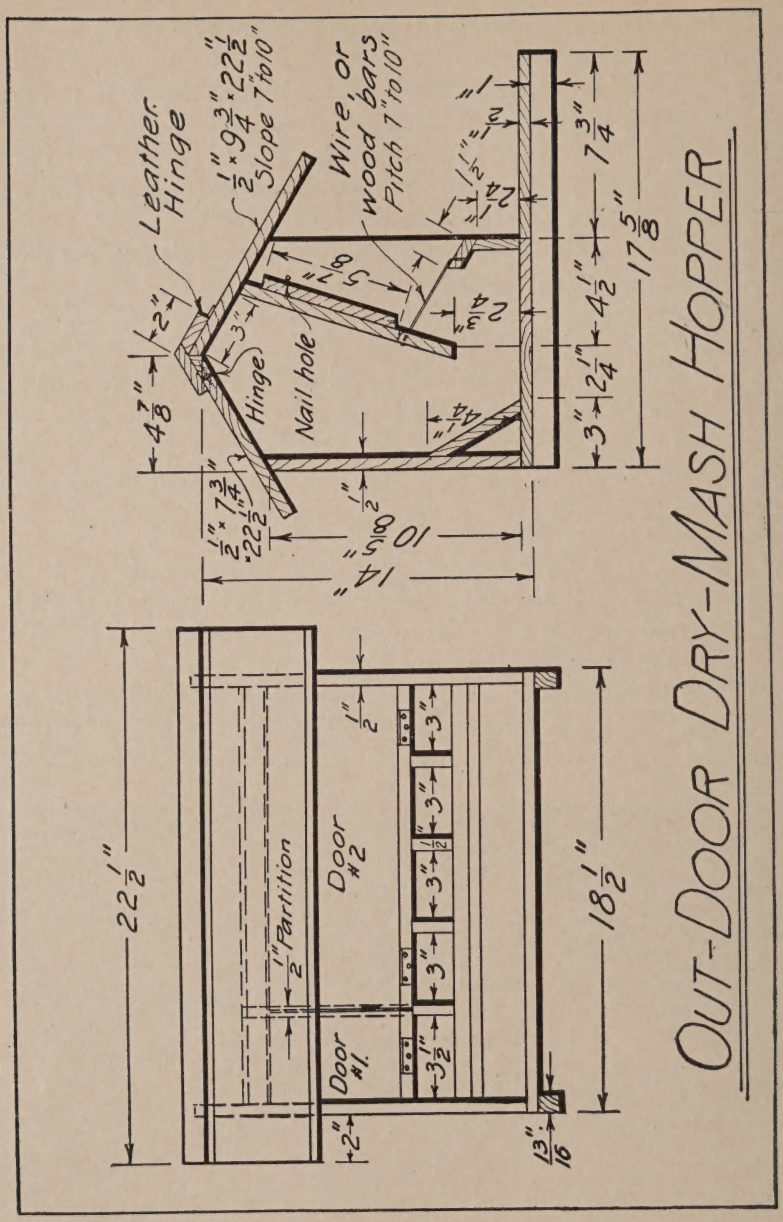


FIG. 63. OUTDOOR DRY-MASH HOPPER

Two doors are provided, either or both of which may be raised and kept up by inserting a nail through a small hole made for the purpose in the sides.

Feed is placed in the hopper through a hinged lid. In order to make the top rain proof an extra ridge board has been provided which is hinged so that it can easily be moved aside when the hinged lid is to be opened.

2. *Material required.*

a. *Lumber.* White pine, cypress, cedar, yellow poplar, etc.

No. of Pieces	Dimensions	Purpose
2	½″ × 9¾″ × 13½″	Sides
1	½″ × 10¾″ × 17½″	Back
1	½″ × 7¾″ × 18½″	Bottom
1	½″ × 9¾″ × 18½″	Bottom
1	½″ × 9¾″ × 22½″	Top
1	½″ × 1″ × 22½″	Top
1	½″ × 7¾″ × 22½″	Top
1	½″ × 4¾″ × 17½″	Baffle board
1	½″ × 9¾″ × 13½″	Partition
1	½″ × 2″ × 22½″	Ridge board
1	½″ × 2½″ × 22½″	Ridge board
1	½″ × 2½″ × 17½″	Front
1	½″ × 1½″ × 17½″	Front
1	½″ × 9¾″ × 17½″	Front (partition)
1	½″ × 5⅞″ × 17½″	Front lids
4	½″ × ½″ × 3″	Division bars
2	13/16″ × 13″ × 17⅝″	Bottom cleats

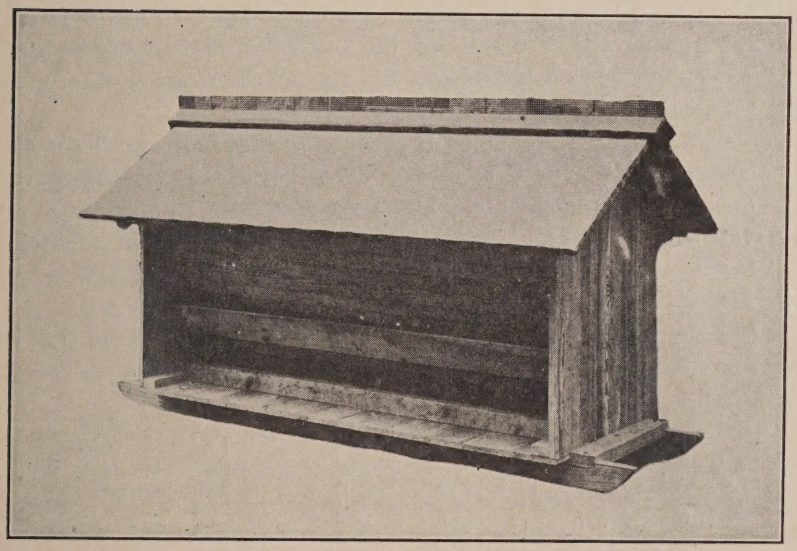


Fig. 64. Portable Out-Door Feed Hopper

b. *Hardware.*

¼ lb. 6d. wire finishing nails.

⅛ lb. 1 or 1¼″ wire brads.

1 doz. ⅝″ flat head brass screws (for leather hinges).

5 2″ or 3″ narrow firm joint butt hinges with screws.

c. *Paint.* A small quantity of paint, or of boiled linseed oil.

3. *Directions.*

a. The construction of this hopper is similar to those already discussed. The most difficult part of the work consists in fitting in the partition that runs crosswise, and the upper part of the front

which may be thought of as a partition running lengthwise of the hopper. If the working drawing and the photograph of the completed hopper, Fig. 62, are noted closely the method of construction should be quite evident.

b. The lid covering the openings through which the birds feed may or may not be made in two parts as shown depending upon personal preference.

c. Instead of the wooden division bars shown in the front view of the drawing, wire bars may be inserted as shown in the side view.

d. Paint or apply linseed oil to the hopper.

One-Hen Brooder Coop

1. *Purpose.* A good many one-hen brooder coops are used in connection with small flocks of poultry. Sometimes a barrel is turned on one side, or a dry-goods box may be provided for the setting hen, but such makeshift provisions do not give the hen, nor the young chicks when they are hatched, the protection that should be theirs. They should be protected not only against the weather, but against rats, cats, dogs, etc.

The figure "A" one-hen brooder coop that is shown herewith is comparatively simple to make. The roof is set over the bottom, but is not fastened to it. The front door with its wire panel provides ventilation and protection. It is made as shown in detail in the drawing of the two-hen incubation and brooder coop.

2. *Material required.*

a. *Lumber.* Usually box or crating material may be found that will serve the purpose. Many kinds of lumber can be used.

No. of Pieces	Dimensions	Purpose
6	$\frac{13}{16}$″ × 8¾″ × 24″	Top
4	½″ × 1½″ × 21″	Battens
2	½″ × 3″ × 26″	Ridge boards
3	$\frac{13}{16}$″ × 7¾″ × 30″	Bottom
2	$\frac{13}{16}$″ × 2″ × 22″	Cleats for bottom
4	$\frac{13}{16}$″ × 2″ × 19″	Cleats for front and back
1	$\frac{13}{16}$″ × 2″ × 16″	Cleats for front
1	$\frac{13}{16}$″ × 1″ × 3″	Turn-button
2	$\frac{13}{16}$″ × 2″ × 10″	Door
2	$\frac{13}{16}$″ × 2″ × 8″	Door
2	$\frac{13}{16}$″ × 2″ × 22″	Cleats for roof

b. *Hardware.*

½ lb. 6d. common wire nails.

¼ lb. 6d. finishing nails.

¼ lb. 3d. common wire nails.

1 1¾″ No. 10 screw, flat head, bright.

3. *Directions.*

a. Cut the bottom boards 30″ long with a 45 degree bevel on each end. Nail the boards to the bottom cleats.

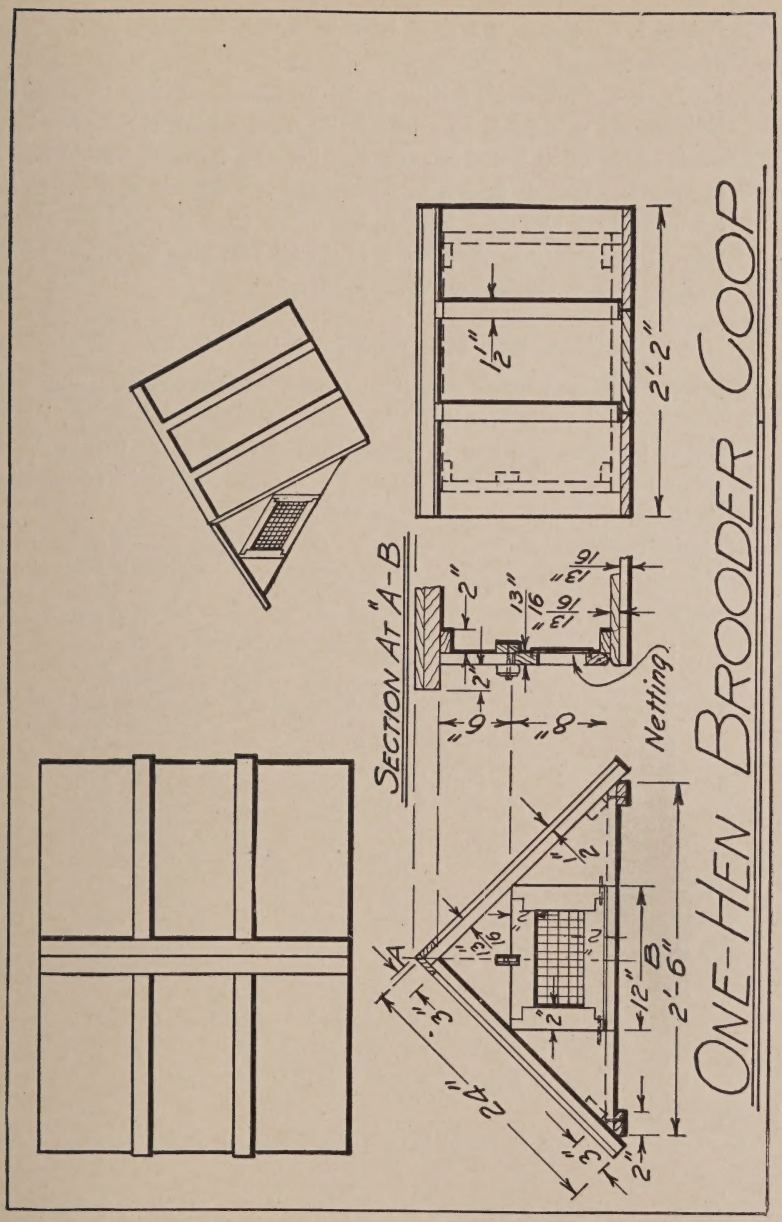


FIG. 65. ONE-HEN BROODER COOP

b. In cutting the boards for the roof notice that the boards on one side are 24″ long, while on the other side they are 13/16″ shorter. Nail them together at right angles to each other at the ridge, and to the cleat which is 3″ from the lower end.

c. The ridge boards and roof battens can be fastened with 3d. common wire nails in such a way as to make a rainproof job.

Instead of these the roof boards could be covered with tar paper.

d. Make the door out of $^{13}/_{16}'' \times 2''$ material. Pivot it near the bottom by using 8d. common nails from which the heads have been cut. Drill holes for these nails, and hang the door before nailing the boards fast that fit around the door. Note that the lower edge of the door is rounded off so that it will turn all the way to the ground. The door could also be hinged, either at the top or bottom instead of being pivoted.

Portable Run-Way for Figure "A" Coop

1. *Purpose.* Those who do not like to use a rectangular run-way with a Figure "A" coop can use one made as shown herewith. This run-way is light, and can be easily moved from place to place. It is not as roomy as the rectangular run-way shown in connection with the two-hen incubation and brooder coop.
2. *Material required.*

a. *Lumber.* Spruce, fir, yellow pine, etc.

No. of Pieces	Dimensions	Purpose
2	$1'' \times 2'' \times 2'6''$	Ends
2	$1'' \times 2'' \times 5'10''$	Sides
2	$1'' \times 2'' \times 5'10''$	Ridges
2	$1'' \times 2'' \times 12''$	Front and back
4	$1'' \times 2'' \times 9''$	Front and back
2	$1'' \times 2'' \times 10''$	Top door
2	$1'' \times 2'' \times 10''$	Top door
2	$1'' \times 2'' \times 8''$	Back door
2	$1'' \times 2'' \times 7''$	Back door
2	$1'' \times 1'' \times 3''$	Turn-buttons
1	$1'' \times 2'' \times 10''$	Top

b. *Hardware.*

½ lb. 8d. finishing nails.
¼ lb. 6d. finishing nails.
1 lb. ½" poultry netting staples.
2 pcs. 1" mesh poultry netting $18'' \times 6'$.
1 pc. 1" mesh poultry netting $12'' \times 6'$.
1 pc. 1" mesh poultry netting $12'' \times 3'$.

3. *Directions.*

a. Complete the doors and insert pivot nails before assembling the run-way.

b. The corners may be reinforced with pieces of $1'' \times 2''$ material or with a heavy wire.

c. To bend poultry netting at a sharp angle, place it between two boards and hammer into shape with a piece of board.

Two-Hen Incubation and Brooder Coop

1. *Purpose.* The brooder coop shown in Fig. 67 is intended to accommodate two hens. When the chicks are hatched the central

partition is slid out thus making the whole coop available for one hen with a good sized brood. The other hen being returned to the laying pen.

The brooder has several attractive features. It is exceptionally accessible, it is very easy to clean, it is well ventilated, and affords proper protection for the mother hens.

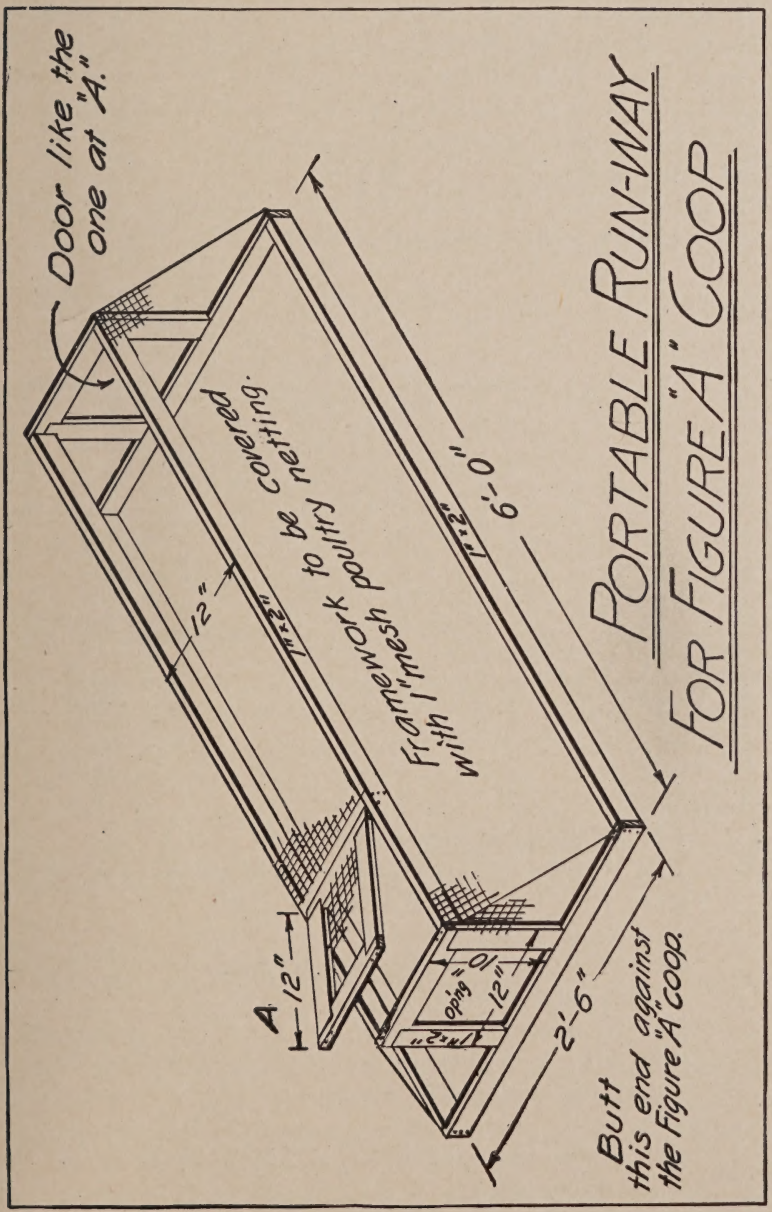


FIG. 66. PORTABLE RUNWAY FOR FIGURE "A" COOP

The bottom and top are not nailed to the sides so either can easily be removed. The dividing partition likewise is simply slid between the guide strips so that the entire coop can be easily cleaned and disinfected.

A hinged board that ordinarily falls back upon the roof of the coop can easily be dropped down in case of heavy storms. Further protection is ordinarily not required if the back or low end of the coop is set so it faces the direction from which the prevailing storms come. Additional protection can be supplied however by fitting small boards ½″ thick against the screen in the two lower doors. These boards may be held in place with small turn buttons so that they can be inserted or removed in a moment.

2. *Material required.*

a. *Lumber.* Box or crating material. Tongued and grooved material is best for sides and bottom.

No. of Pieces	Dimensions	Purpose
7	13/16″ × 5¾″ × 22⅛″	Bottom
2	13/16″ × 3¾″ × 3′ 6″	Bottom (cleats)
7	13/16″ × 5¾″ × 22⅜″	Sides
2	13/16″ × 2″ × 13½″	Cleats for corners of coop
2	13/16″ × 2″ × 20½″	
3	13/16″ × 5¾″ × 3′ 6″	Back
2	½″ × ½″ × 13½″	Guide strips
4	½″ × 5¾″ × 22″	Partition
8	13/16″ × 5¾″ × 30″	Top
1	13/16″ × 8¾″ × 3′ 10″	Top (swinging board)
2	13/16″ × 2″ × 3′ 4⅜″	Cleats for top
2	13/16″ × 3¾″ × 22⅛″	Corner boards
1	13/16″ × 3¾″ × 3′ 2″	Cross-piece
1	13/16″ × 2″ × 3′ 2″	Cross-piece
1	13/16″ × 2″ × 3′ 4″	Front cross-piece
1	13/16″ × 2″ × 9¾″	Upright
1	13/16″ × 2″ × 4¾″	Upright
4	13/16″ × 2″ × 9¾″	Front doors
4	13/16″ × 2″ × 14″	Front doors
1	13/16″ × 1″ × 4″	Turn button
2	½″ × 1½″ × 20½″	Door stops

b. *Hardware.*

1 pr. 8″ strap hinges with screws.
1 1¾″ No. 8 or 10 screws, flat-head, bright.
2 pcs. 7″ × 20″ hardware cloth ½″ mesh.
or else poultry wire, 1″ mesh.
2 pcs. 8″ × 14″ hardware cloth ½″ mesh.
or else poultry wire, 1″ mesh.
½ lb. 6d. common wire nails.
½ lb. 8d. wire finishing nails.
¼ lb. ½″ galvanized wire staples.

c. *Roofing.*

1 pc. roofing paper, or tin 32″ × 3′ 10″.
2 doz. roofing tacks.

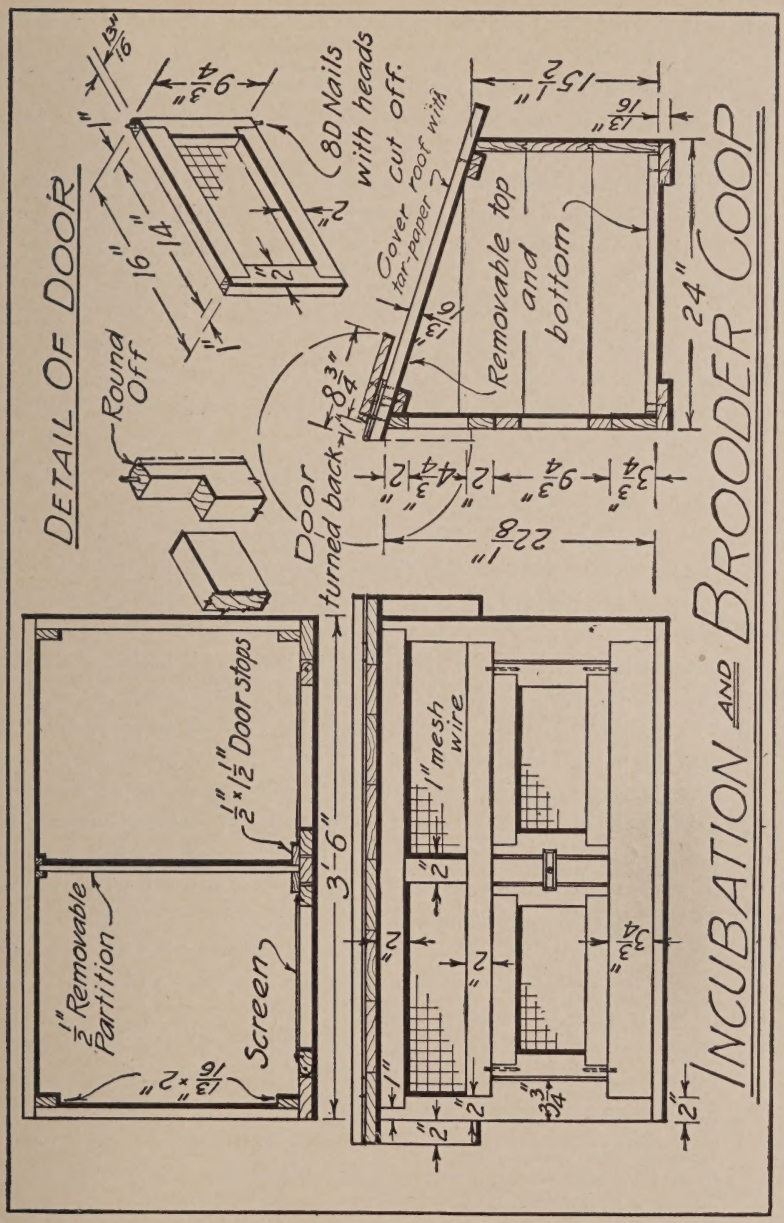


FIG. 67. INCUBATION AND BROODER COOP

3. *Directions.*

a. To construct the bottom nail the flooring material to the bottom cleats in such a way that the sides will come directly on the cleats all around, and so that the bottom boards will fit between the sides, leaving ⅛″ space at both ends and sides to allow for expansion; this is shown in the cross-section view Fig. 67.

b. Cut the material for the two sides using the beveled piece that is cut from the one side for a similar space on the opposite side. Nail the side boards to the 1″ × 2″ cleats.

c. Next nail the boards forming the back tightly against the sides, and square to the latter.

d. The front of the coop is the most difficult part to make. Begin by cutting the various pieces as listed in the bill of material, and fit them together as shown in the working drawing. The corner boards (uprights) are nailed in place one at a time. Fasten the three long pieces running across the front to the uprights with 8d. finishing nails, using a nail set. Before they are fastened however the doors must be made and they must be hung in place by means of nails on which they pivot. Small holes should be drilled for the pivot nails.

e. The doors are not at all difficult to make. The process is shown in the detailed drawing.

f. The hardware cloth or the poultry wire is fastened to the inside of the doors and the openings above them with wire staples ⅝″ long. Place these staples in such a way that they will not split the wood.

g. The swinging board that is hinged to the roof is fastened on after the roofing material has been put on.

h. "Prepared" roofing material such as various papers, that are treated by the manufacturer with asphalt and other compounds are usually fastened with flat-head roofing tacks or else with shingle-nails and tin washers. Place these along the edges of the boards (not on the flat surfaces). Before nailing roofing material in place it should be exposed to the warm sun for several hours so that it will expand before being nailed down. Otherwise the material will buckle up and wrinkle during warm weather. The larger the surface the more important it becomes to expand prepared roofing before it is nailed in place.

i. Observe that the top swinging board that is hinged to the roof is hinged one inch back from the hinge joint so that it will pass the projecting roof, and fit against the front of the coop.

j. In making turn buttons such as shown in the drawing it is best to drill through the button a hole of the same diameter as the screw that is to be used.

k. The back and the sides of the coop should be air tight. If tongued and grooved lumber is not at hand, either use lathes or other strips over the joints or put tar-paper around the back and sides as well as on the roof. It is well to place the coop in a protected place and where it is easy to reach. Use hay or straw for nesting material. Shavings are not satisfactory for nesting material for a setting hen.

Portable Run-Way for Chicks

1. *Purpose.* The run-way shown in Fig. 68 is planned for the brooder coop Fig. 67.

A portable run-way has many advantages over a stationary one. Green food and fresh clean soil are essential in rearing chicks. An

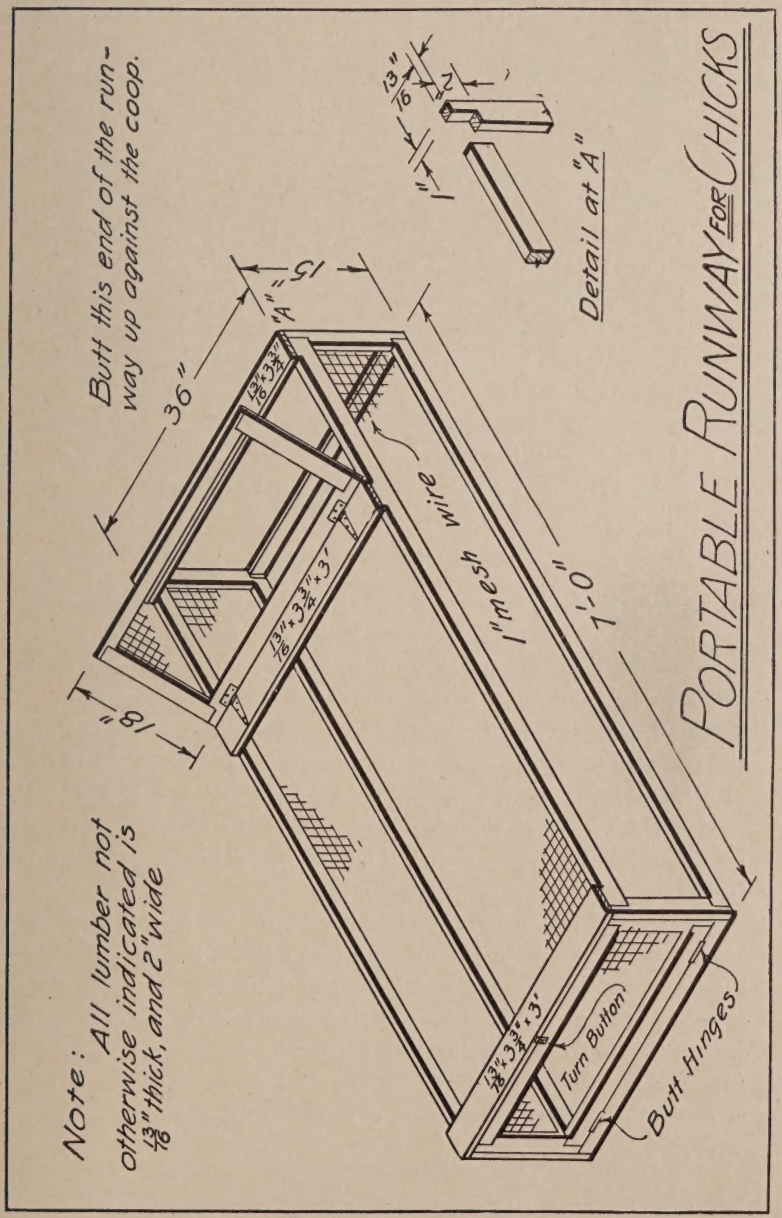

PORTABLE RUNWAY FOR CHICKS
Butt this end of the run-way up against the coop.
36"
"A" = 15"
Detail at "A"
1" mesh wire
1'-0"
Turn Button
Butt Hinges
Note: All lumber not otherwise indicated is 13/16" thick, and 2" wide

FIG. 68. PORTABLE RUNWAY FOR CHICKS

easy way to supply these things is by using portable coops and runways.

2. *Material required.*

a. *Lumber.* Spruce, or other light wood.

No. of Pieces	Dimensions	Purpose
4	$^{13}/_{16}$″ × 2″ × 6′ 10″	Sides
3	$^{13}/_{16}$″ × 3¾″ × 3′	Cross-pieces (top)
2	$^{13}/_{16}$″ × 2″ × 3′	Cross-pieces (bottom)
4	$^{13}/_{16}$″ × 2″ × 15″	Uprights
2	$^{13}/_{16}$″ × 2″ × 3′	Top door
2	$^{13}/_{16}$″ × 2″ × 16″	
2	$^{13}/_{16}$″ × 2″ × 2′ 8″	End door
2	$^{13}/_{16}$″ × 2″ × 13″	
2	$^{13}/_{16}$″ × 1″ × 3″	Turn buttons

b. *Hardware.*

17 lineal feet of poultry wire 12″ wide, 1″ mesh.
7 lineal feet of poultry wire 36″ wide, 1″ mesh.
1 pr. 3″ T hinges with screws.
1 pr. 3″ firm joint butt hinges with screws.
(Home-made leather hinges may be used in place of the steel hinges specified).
¾ lb. ½″ poultry netting staples.
½ lb. 8d. finishing nails.
2–1¾″ No. 8 or 10 wood-screws, flat-head, bright.

Double-Tier Wall Nests

1. *Purpose.* Various types of nests are in use by progressive poultrymen. The construction differs with the design of the poultry house. Sometimes nests may best be placed on the side walls, at other times they fit in better under the dropping boards.

The double-tier wall nests herewith illustrated are substantially the same as those designed by the Poultry Husbandry Department of Purdue University, and shown in their Bulletin No. 211.

It will be noticed that the nests are easily cleaned as they can be unhooked from the wall. The steep top board prevents birds from roosting on top of the nests.

An unusual feature is found in the "running boards" which are hinged to the nests in such a way as to make it easily possible to lift them out of the way and close the nests with them in the late afternoons and evenings so as to exclude broody hens or to keep young chicks from roosting in the nests.

2. *Material required.*

a. *Lumber.* Yellow pine, spruce, Douglas fir, etc.

No. of Pieces	Dimensions	Purpose
5	$^{13}/_{16}$″ × 11¾″ × 3′	Sides and partitions
1	$^{13}/_{16}$″ × 11¾″ × 4′ 2$^{7}/_{16}$″	Bottoms

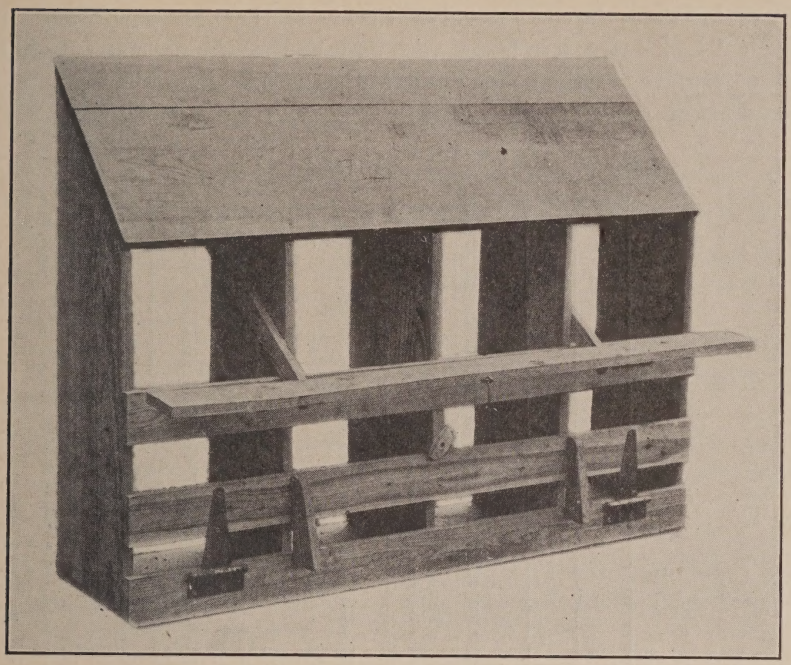


FIG. 69. WALL NEST
Designed and built at Purdue University.

NO. OF PIECES	DIMENSIONS	PURPOSE
4	$13/16'' \times 11\frac{3}{4}'' \times 12''$	Bottom
2	$13/16'' \times 5\frac{3}{4}'' \times 4'\ 5\frac{11}{16}''$	Top
1	$13/16'' \times 7\frac{3}{4}'' \times 4'\ 5\frac{11}{16}'$	Top
1	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 4'\ 4\frac{1}{16}''$	Support for nests
2	$13/16'' \times 3\frac{3}{4}'' \times 4'\ 4\frac{1}{16}''$	Fronts for nests
2	$13/16'' \times 3\frac{3}{4}'' \times 4'\ 4\frac{1}{16}''$	Running boards
4	$13/16'' \times 2\frac{1}{2}'' \times 6''$	Brackets
1	$13/16'' \times 1'' \times 3''$	Turn-button

b. *Hardware.*

4 heavy T hinges with 6″ strap and screws.
1 2 or 3″ hook and screw-eye.
2 3 or 4″ hook and screw-eye.
1 1¾″ No. 10 steel wood-screw, flat-head (for turn-button).
½ lb. 8d. common wire nails.
½ lb. 8d. finishing nails.
¼ lb. 6d. finishing nails.

3. *Directions.*

a. Cut out the sides and the partitions using the first side as a pattern for the remainder.
b. The bottom board for the lower tier of nests may be cut to length and can be nailed to the sides and partitions.
c. Tack a strip across the top ends of the sides and partitions spac-

ing them the same as below, that is, 12″ between partitions. To "tack" means to fasten with nails so that the nails can easily be removed — the heads are left sticking out about ¼″.

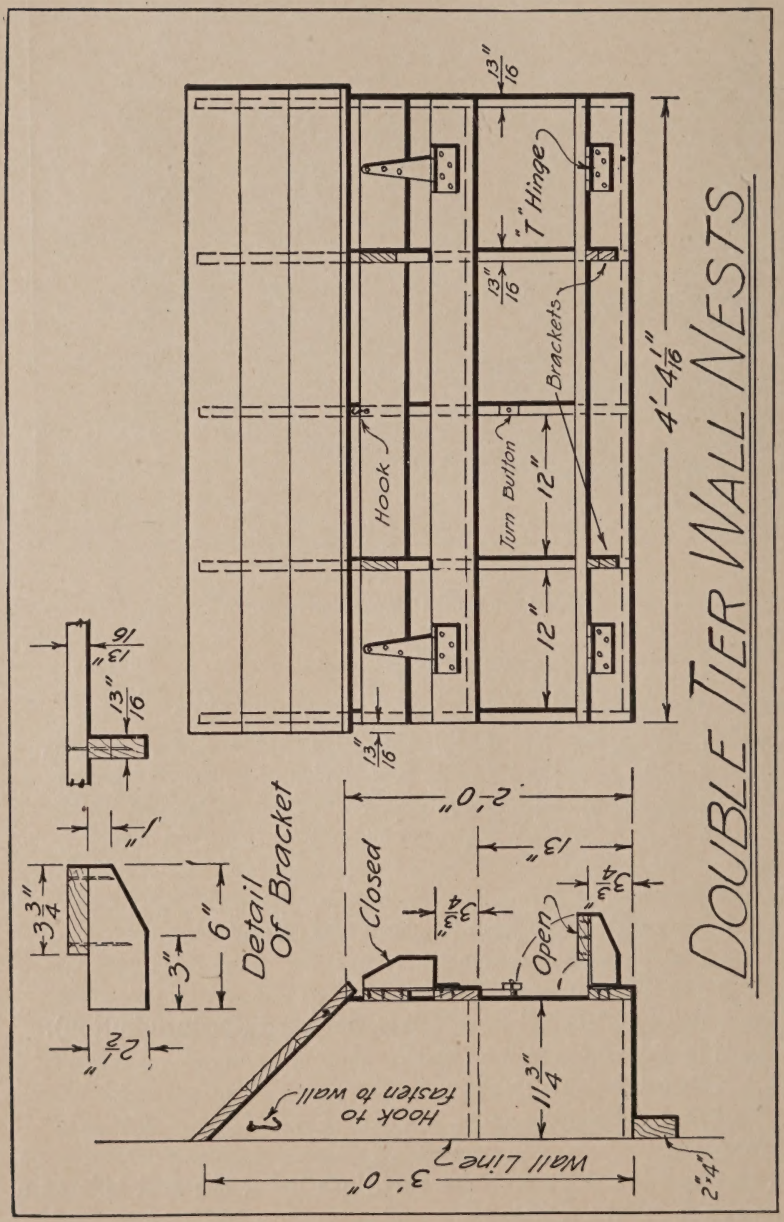


FIG. 70. DOUBLE TIER WALL NESTS

d. Fit the bottoms into the upper tier nests one at a time. Nail the pieces through the partitions instead of trying to toe-nail them to the partitions.

e. The top may next be nailed firmly in place. A detachable top could also be made if desired.

f. Nail the boards in place that form the fronts of the nests, cut out the brackets as shown in the detail drawing, and fasten in place with the T hinges.

g. Fasten the 2″ × 4″ support that is to carry the weight of the nests on the wall and adjust the screw eyes and hooks that hold the nests to the walls.

Nests under Dropping Board

1. *Purpose.* The object in placing nests under dropping boards is to save space in the poultry house. The nests shown in the accompanying drawing have several good features.

   a. The bottom and the running board are nailed on cleats, and are entirely separate from the rest of the nest, which makes cleaning easy.

   b. The nests are simple in construction.

   c. They are placed in a darkened position which hens like.

   d. A front door, fastened with a turn-button makes the collection of eggs an easy matter.

2. *Material required* (for six nests).

   a. *Lumber.* Spruce, hemlock, yellow pine, etc.

No. of Pieces	Dimensions	Purpose
6	$^{13}/_{16}$″ × 11¾″ × 14″	Sides and partitions
5	$^{13}/_{16}$″ × 3″ × 6′ 5$^{11}/_{16}$″	(T and G) flooring
1	$^{13}/_{16}$″ × 7¾″ × 6′ 5$^{11}/_{16}$″	Running boards
1	$^{13}/_{16}$″ × 3¾″ × 6′ 5$^{11}/_{16}$″	Back
1	$^{13}/_{16}$″ × 3¾″ × 6′ 5$^{11}/_{16}$″	Front
1	$^{13}/_{16}$″ × 3¾″ × 2″	Front
4	$^{13}/_{16}$″ × 3¾″ × 2′	Bottom cleats
1	$^{13}/_{16}$″ × 1″ × 3″	Turn-button
3	1¾″ × 3¾″ × width of dropping platform	Beams for brackets
3	1¾″ × 3¾″ × ? (depends on above dimensions)	Braces for brackets

   b. *Hardware.*

   2 6″ strap hinges with screws.
   1 1¾″ No. 10 screw, flat head, bright (for turn-button).
   1 lb. 16d. common wire nails.
   ½ lb. 6d. common wire nails.
   ¼ lb. 8d. common wire nails.
   ¼ lb. 8d. finishing nails.

3. *Directions.*

   a. Nail the flooring or other boards that are to form the bottom of the nest fast to the bottom cleats. Also nail the running board to these cleats.

   b. The partitions and end pieces are held in position by three strips of lumber: one at the back of the nest and two at the front.

Nail these pieces together, making certain that the board which is to form the front door for removing the eggs, will have plenty of space. Allow about ¼″ for expansion of this front door.

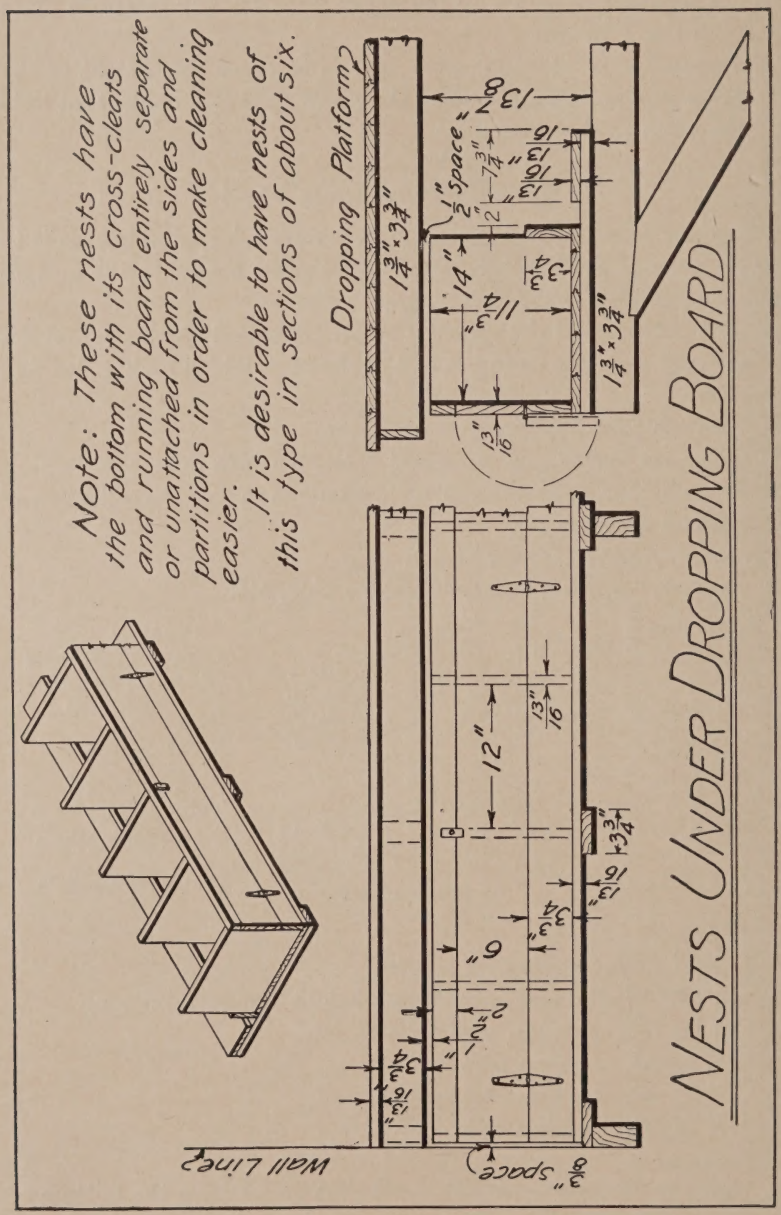

Note: These nests have the bottom with its cross-cleats and running board entirely separate or unattached from the sides and partitions in order to make cleaning easier.
It is desirable to have nests of this type in sections of about six.
Dropping Platform
NESTS UNDER DROPPING BOARD
Wall Line
⅜" Space
12"
6"
14"

FIG. 71. NESTS UNDER DROPPING BOARD

c. Fasten the front door in place with the strap hinges, and the turn-button.

d. The 2″ × 4″ supporting brackets can be put in as shown or a

post can be used instead of the bracket. The nests can also be hung from the dropping platform.

e. Notice that the front of the nests is set back from the front of the over-head platform about three inches.

Wall Type Nests

1. *Purpose.* The wall type nest shown in the accompanying drawing is a modification of the design recommended by the Department of Poultry Husbandry of the Kansas State Agricultural College in their Circular No. 61.

The drawing given herewith shows the nest with the bottom and top removable instead of the front as shown in the Kansas Circular.

This type of wall nest has the advantage in providing darkened nests, from which eggs can be gathered easily. It is also easily cleaned, and can be closed when desired.

2. *Material required.*

a. *Lumber.* Spruce, hemlock, etc.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{16}'' \times 11\frac{3}{4}'' \times 6'\ 7\frac{11}{16}''$	Top boards
5	$1\frac{3}{16}'' \times 3'' \times 6'\ 6\frac{5}{16}''$	Flooring
1	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 7'\ 8''$	Running board
1	$1\frac{3}{16}'' \times 11\frac{3}{4}'' \times 6'\ 5\frac{11}{16}''$	Front
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 6'\ 5\frac{11}{16}''$	Back
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 3'\ 1''$	Cleats for top
3	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 2'\ 2''$	Cleats for bottom
7	$1\frac{3}{16}'' \times 14'' \times 2'$	Ends and partitions
1	$1\frac{3}{16}'' \times 9\frac{3}{4}'' \times 12''$	Sliding door
1	$1\frac{3}{16}'' \times 1\frac{3}{16}'' \times 2'$	Guide strip for door
2	$\frac{1}{4}'' \times 1\frac{1}{2}'' \times 2'$	Guide strip for door
4	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 2'\ 7''$	Beam for bracket
3	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 3'$	Brace for bracket

b. *Hardware.*

1 pr. 6″ strap hinges with screws.
1 lb. 16d. common wire nails.
½ lb. 6d. common wire nails.
¼ lb. 8d. common wire nails.
¼ lb. 8d. finishing nails.

3. *Directions.*

a. The flooring boards and the running board are nailed to cleats but not to the sides or ends of the nests in any way, so that they are separate and easy to remove for cleaning and disinfecting purposes.

b. The end pieces and the partitions are held in place by being nailed to the front board, and to two strips at the back — one at the top and one at the bottom.

c. The top is made detachable by nailing the boards to cleats which rest against the front of the nest and on a strip nailed to the wall. A small "scab" or piece of waste lumber should be nailed against the board forming the front of the nest in such a way as to catch

the cleats to which the top is fastened. This is shown in the cross-section of the working drawing.

d. The top could also be hinged to the wall in such a way as to

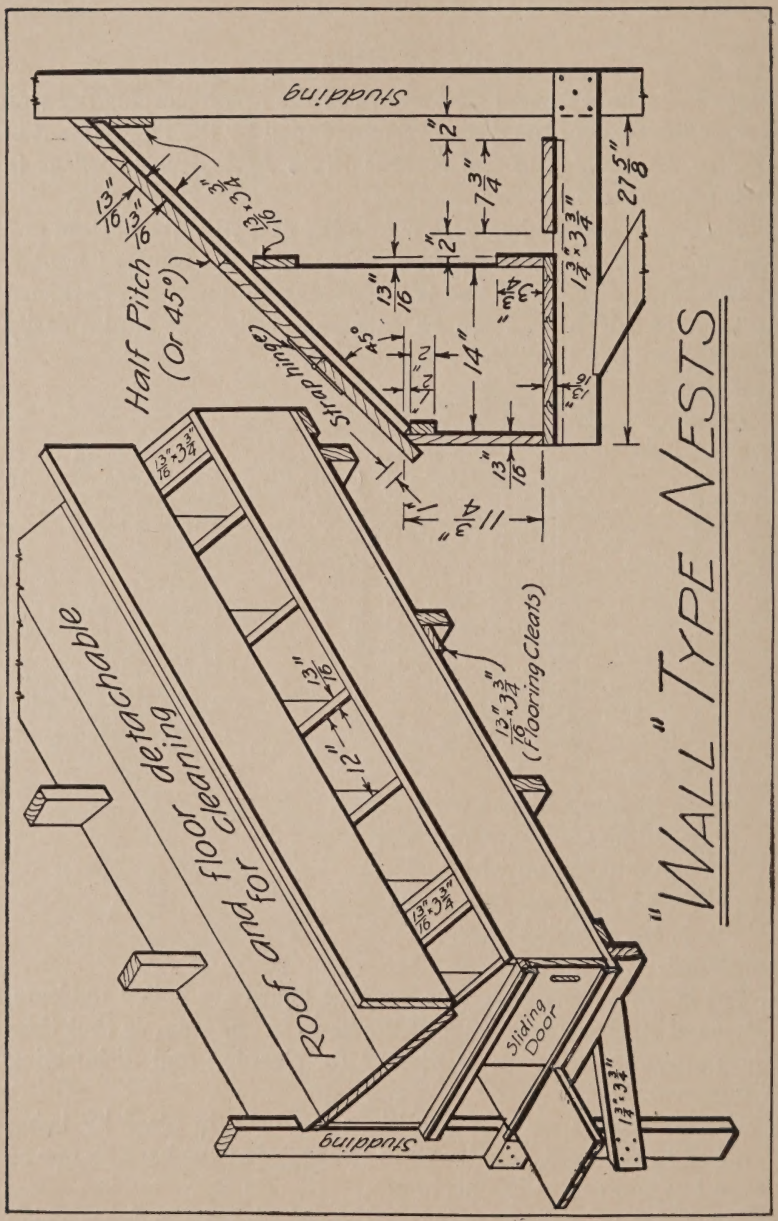


FIG. 72. "WALL" TYPE NESTS

permit the nests to be removed easily. A sheet of corrugated iron could be used for the roof, the corrugations running up and down.

Trap Nests

1. *Purpose.* Trap nests are used primarily by poultrymen who wish to keep an accurate record of the egg-production of individual hens, and who may wish to keep separately the eggs from particular birds for hatching purposes. The trap nest is not frequently used in connection with the average farm flock because considerable attention is required to carry on trap-nesting.

   Since trap nests are valuable for those who can give the necessary time to them, a working drawing and explanation are given herewith of a form of trap nest that is now used in many States. It has been used in slightly varying forms for years by the poultry department of a number of State colleges. (See Extension Circular No. 47, *Farm Poultry,* The Pennsylvania State College).

2. *Material required* (for a battery of 4 nests).

   a. *Lumber.* Spruce, hemlock, yellow pine, Douglas fir, etc.

No. of Pieces	Dimensions	Purpose
5	13/16″ × 11¾″ × 18″	Ends and partitions
3	13/16″ × 2¾″ × 4′ 4 1/16″	Front, back and division strip
1	13/16″ × 2″ × 4′ 4 1/16″	Back
4	13/16″ × 5¾″ × 11½″	Doors
4	13/16″ × 1¼″ × 6″	Triggers
2	1¾″ × 3¾″ × 2′	Beams for brackets
2	1¾″ × 3¾″ × 2′	Braces for brackets
8	13/16″ × 3″ × 4′ 4 1/16″	Flooring
1	13/16″ × 5¾″ × 4′ 4 1/16″	Running board
2	13/16″ × 3¾″ × 2′ 4″	Cleats (for flooring)
2	13/16″ × 3¾″ × 1′ 10″	Cleats (for roof)
1	13/16″ × 3¾″ × 4′ 4 1/16″	Strips on which roof rests
8	13/16″ × 3″ × 4′ 6″	Roof

   b. *Hardware.*

   1 pr. 6″ strap hinges with screws.
   8 1″ wire screw eyes.
   5 feet baling, or other wire about 1/16″ to 1/8″ thick.
   2 1¾″ No. 10 screws, flat-head, bright.
   4 1¾″ No. 10 screws, round-head (for triggers).
   4 leather washers for these screws.
   1 lb. 6d. common wire nails.
   ½ lb. 8d. finishing nails.
   ½ lb. 16d. common wire nails.

3. *Directions.*

   a. The flooring and running board are nailed to cleats and not attached to the trap nest in any way.

   b. The partitions and end pieces are nailed in place through the strips running at the front and back.

   c. The 13/16″ × 3¾″ strip that is located 12″ from the back of the nest, and over which the hen steps to get into the nest, is a continuous strip extending from end to end. The partitions and end

pieces are notched to receive this strip. Its purpose is twofold: it keeps the nesting material in place, and it forces the hen to step over it so that she will release the trigger by pushing against

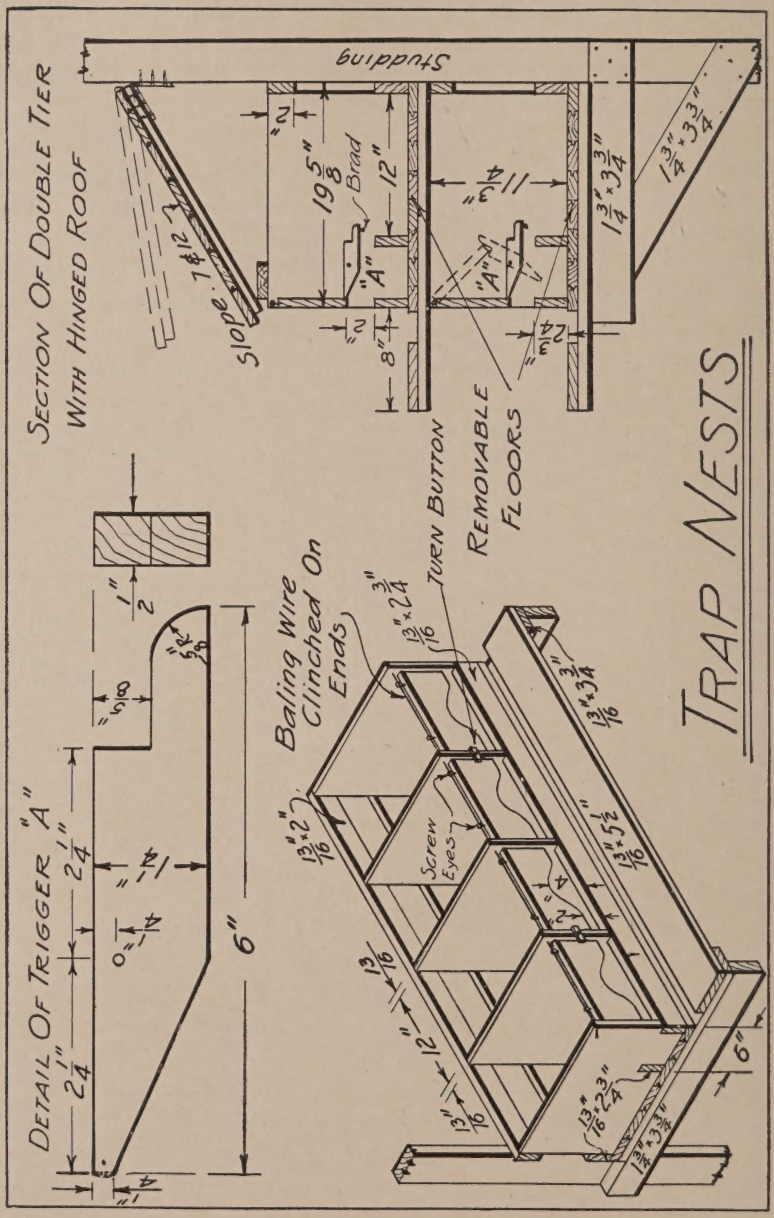


FIG. 73. TRAP NESTS

the edge of the door which is set at an angle as shown by the dash lines in the cross-section view.

d. The roof in this case is hinged to the wall and is made to slope so

that the birds will not roost upon it. Note that it is arranged so that it can be raised enough to allow the trap nests to be drawn out from under it.

e. The triggers should all be adjusted carefully so that they will "spring" when a slight touch is given the door. A leather washer placed between the side of the trap nest and the trigger, and also under the head of the screw holding the trigger will tend to reduce friction.

f. The openings in the doors are rounded off so that the birds will not injure their neck feathers when looking out.

g. Plain boards may be used in place of the tongued and grooved material shown in the drawing.

h. Place the nests so that the first battery is about 14″ above the floor.

i. The bill of material as made out is for one set of four nests with the supporting brackets and the roof. Two or more tiers may be placed one above the other.

Poultry-House Construction

1. *Essential requirements.* A large variety of types of poultry houses are in use throughout the country. There is no single type that is equally well suited to all places. Many poultry houses have been erected, however, without regard to fundamental principles that should govern such construction.

Certain essential requirements are presented herewith.

a. *Economy of structure.* From the standpoint of successful farming, one of the most essential requirements is that the enterprise must be conducted on a paying basis. To favor this, poultry houses should not be too elaborate in design, nor too large in size. The income from the flock should pay for interest on the capital invested, for maintenance, and should render a fair profit in addition.

It will be recognized that true economy does not necessarily consist in buying the cheapest material available. On the contrary, in selecting the type of building, and the kinds of material that are to be used, due consideration should be given to durability and cost of up-keep as well as to the initial cost.

b. *Economy of arrangement.* Success or failure in the poultry business depends to quite an extent upon whether or not everything pertaining to the poultry business is arranged conveniently so that time and labor will be saved. A little additional thought and work put upon labor-saving conveniences such as handy feeding, watering, and laying devices will often change what would otherwise be a loss into profit.

c. *Protection against weather conditions.* Poultry needs to be pro-

tected well against dampness, draft, and extremes in temperature. The dampness may be from one of several sources, namely, rain, soil or surface moisture, and moisture caused through condensation within the poultry house. Poultry houses should be as dry as possible.

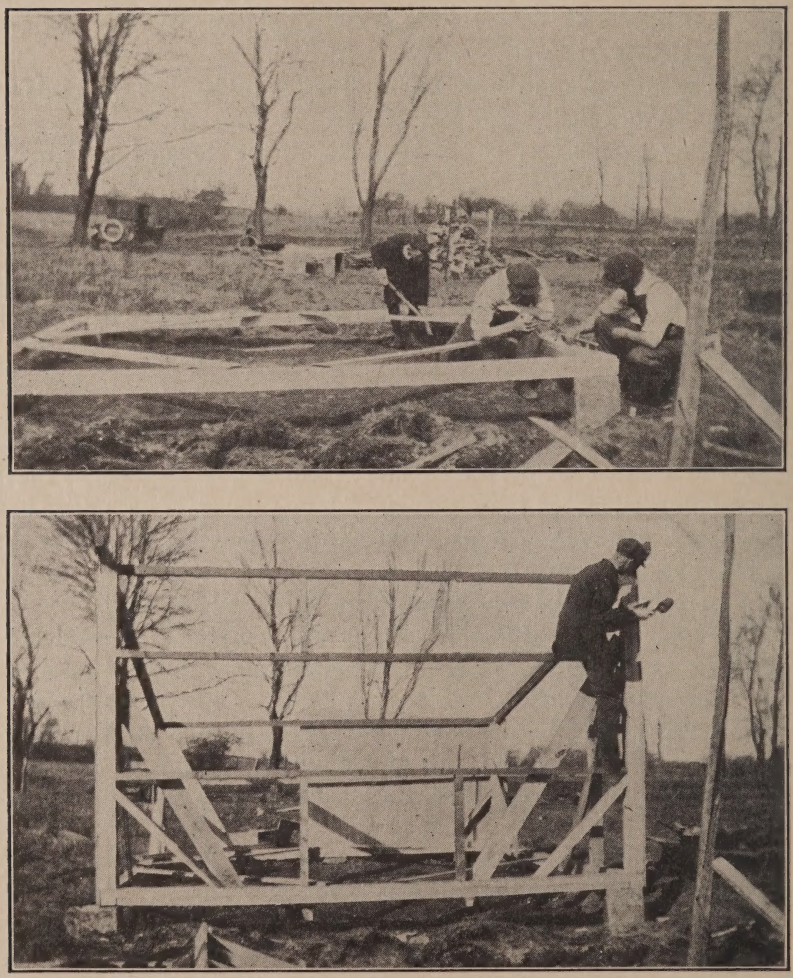


FIG. 74. BOYS BUILDING A POULTRY HOUSE AT MIDDLETOWN, CONN.
Mr. W. C. Kennedy, teacher. Photograph, courtesy of Mr. C. B. Gentry, Connecticut Agricultural College, Storrs, Conn.

Recent practice shows that birds can stand a good deal of cold provided they are kept dry and out of drafts. The New Jersey type of poultry house is more open than the Missouri and the Iowa types.

d. *Ventilation.* The birds from which our present domestic poultry was developed lived in the open. Many poultry houses do not

have sufficient ventilation. There should be an abundance of pure air, without drafts. This can be provided by proper openings for ventilation. There should be no draft over the roosts,

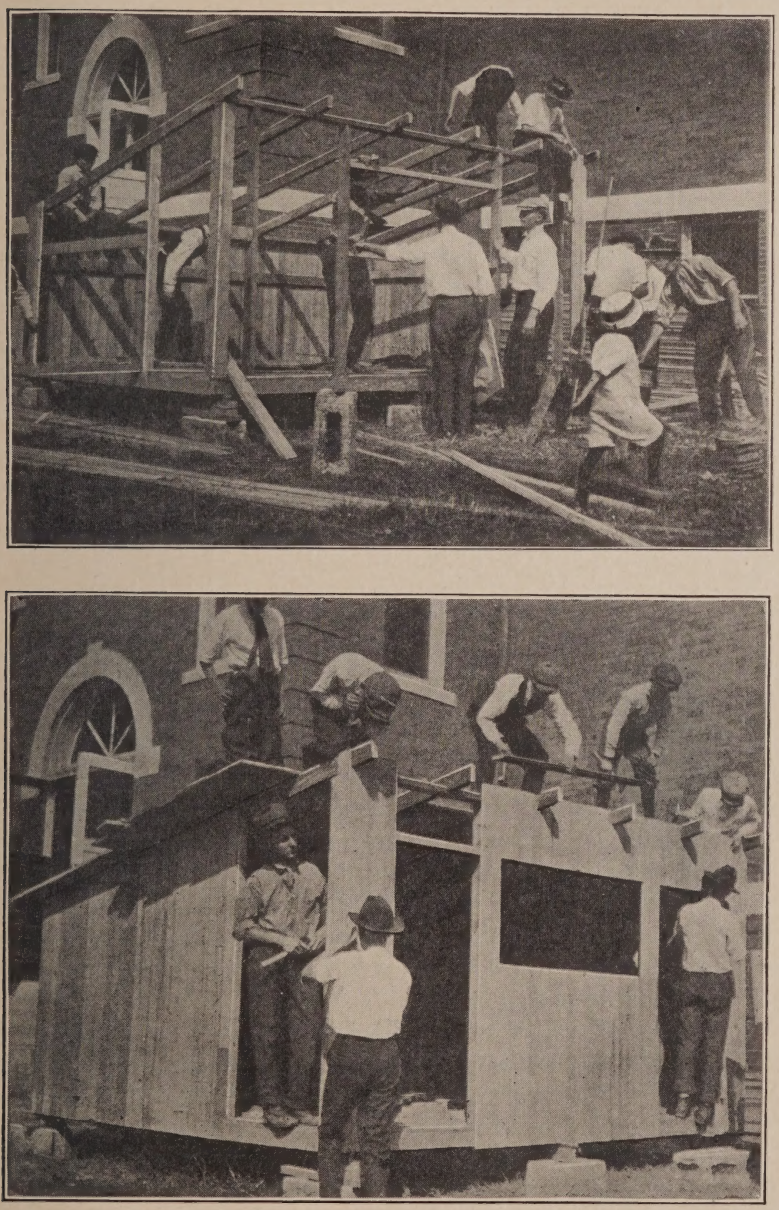


FIG. 75. CLASS AT WAVELAND, INDIANA, BUILDING A SHED ROOF POULTRY HOUSE

Mr. H. V. Raquet, instructor. Photograph, courtesy of Mr. Z. M. Smith, State Supervisor of Agricultural Education, Indianapolis.

particularly since the birds are inactive when roosting and are more likely to catch cold there than elsewhere.

e. *Sunlight.* Sunlight has an energizing effect upon birds as well as upon human beings, and it destroys harmful germs and bacteria. It is therefore desirable to have sunlight in the

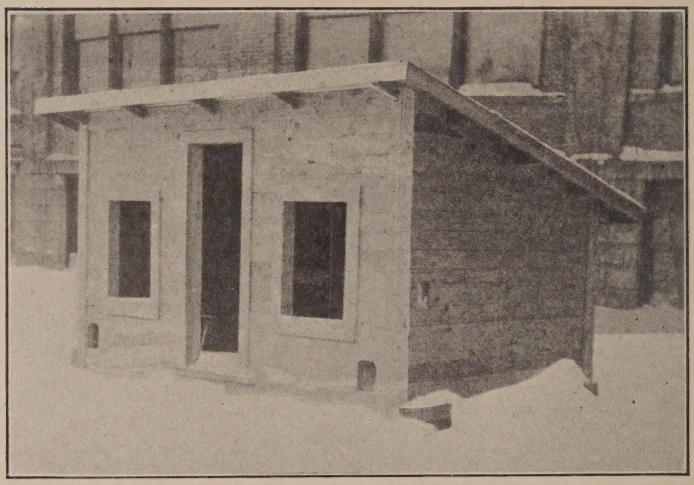


FIG. 76. AN 8′ × 10′ COLONY HOUSE

Built by pupils at Chippewa Falls, Wis. Photograph, courtesy of Mr. G. W. Gehrand, State Supervisor of Vocational Agriculture, Madison, Wis.

poultry house as much as possible, especially during the winter months. Poultry will remain active longer hours during the day, and, other things being equal, will lay more if kept in a well-lighted pen than in a dark one. A number of poultrymen who can obtain electric light cheaply are using artificial light in the poultry house before and after sunset in the winter months in order to "lengthen the day" and increase egg production.

f. *Protection against rats and mice and other vermin.* In some sections of the country rats cause considerable loss to poultrymen. Mice are not so serious a pest, but both can be controlled by using concrete floors and foundations, and by taking other protective measures.

g. *Health and sanitation.* Poultry houses and yards should be as healthful and sanitary as possible. The location should preferably be on a sandy soil having good drainage, and a good exposure with shade in places. The interior finish of the poultry house should be as plain and smooth as possible so that mites, lice, and microbes can be reached with disinfectants.

2. *Types of laying houses.* There are three rather distinct kinds of laying houses. The first of these is the single unit house. Perhaps nine out of every ten farmers who have poultry houses, have this

type of a house. Several examples of this are shown in this chapter; as, for example, Figures 75, 76, 79, and 81.

The second type is the large single unit house in which 100 or more birds are kept. The third type is the large multiple unit house in which a number of small unit flocks are kept. The two latter types are used when poultry is raised on an extensive plan.

The single unit type of house has many variations. Some forms are portable; that is, are placed on skids. Others are stationary. They differ too in size and arrangement. The suburban back-yard poultry house sometimes has two or more decks or levels and a scratching pen underneath, while the farm-unit type of poultry house is built along more ample lines.

FIG. 77. GETTING PRACTICAL EXPERIENCE AT POULTRY HOUSE CONSTRUCTION AT THE KANSAS INDUSTRIAL AND EDUCATIONAL INSTITUTE

Photograph, courtesy of Mr. Wm. R. Curry, Topeka, Kansas.

3. *Size of the laying house.* The amount of floor space that should be allowed per hen depends somewhat upon the size and characteristics of the breed, and upon the knowledge and skill of the caretaker. From three to five square feet of floor space should be allowed per bird. The smaller the coop the greater should be the floor space per bird. Ordinarily it is best to make the house not less than 8′ wide nor less than 10′ deep. The depth is required to provide protection from drafts.

   Houses of the shed-roof type need not be more than four or five feet high at the back or low side, and should be high enough at the front to permit a door to be placed there or just around the side.

4. *Foundations.* Posts, skids, stones, bricks, and concrete are all used for foundations. The conditions obtaining in specific cases will

determine which of these will be used. There is a trend toward the use of concrete for foundations for all except portable poultry houses.

5. *Walls.* In concrete foundations some $2'' \times 6''$ planks are usually laid upon the foundation. These planks are called plates. The studdings are toe-nailed to them. Top plates are also placed on top of the studdings to hold the latter in place, and give support for rafters and openings. The top plates are frequently spiked to studdings before they are raised

   When posts are used for foundations the sills are sometimes made of $4'' \times 6''$ or $6'' \times 6''$ timbers.

   Walls if of wood are usually covered with (a) boards and battens, (b) rustic, (c) siding or other forms of lumber, and the walls are ceiled on the inside, at least around the roosts.

6. *Openings.* Openings should be of proper proportion, and should

FIG. 78. FRONT ELEVATION OF CHICKEN HOUSE $20' \times 40'$
Built by class of Meridian Washington High School, for Ed. Kenoyer.

be correctly spaced. It is desirable to have an abundance of sunlight in the poultry house, but too much glass area is expensive and unsatisfactory because it makes the house hot in summer and cold in the winter time. To overcome this muslin curtains should be used to cover some of the openings. Usually the amount of glass surface should be about 1 square foot per bird provided muslin curtains are also used. The area for the latter should be about

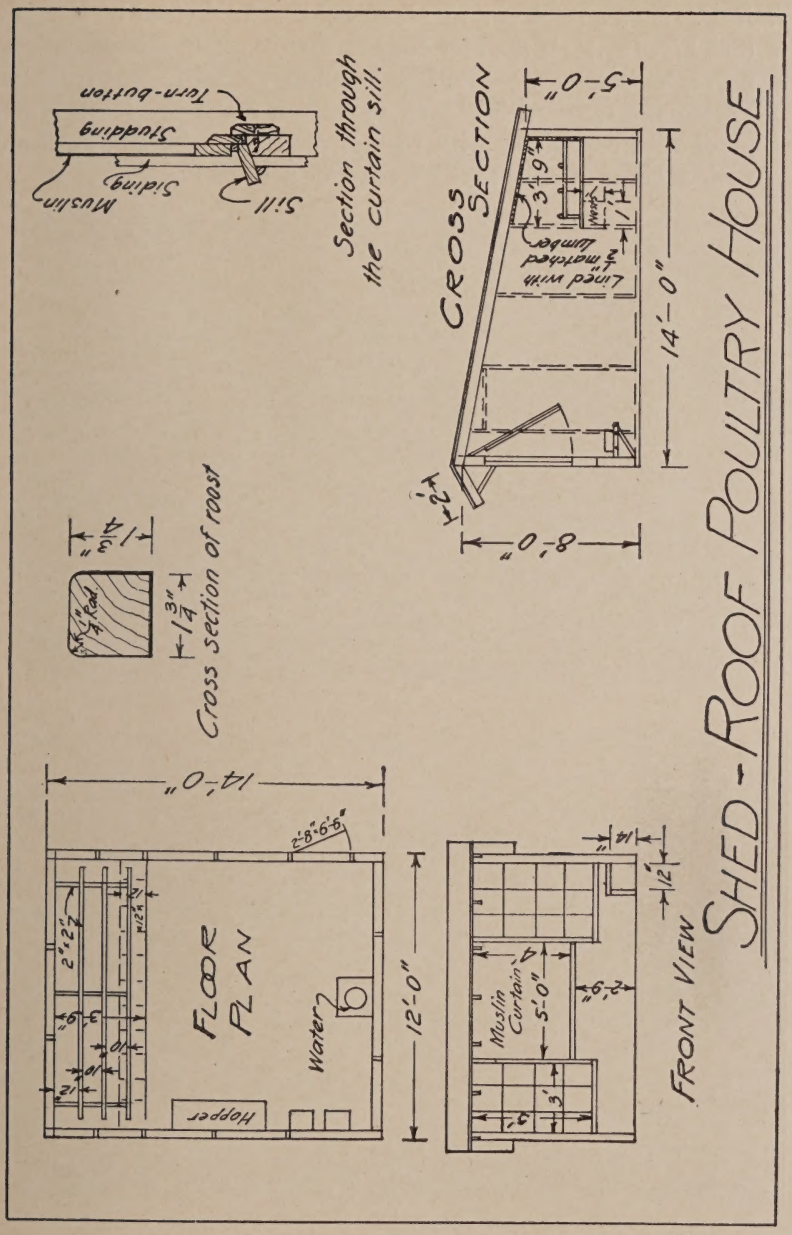


FIG. 79. SHED-ROOF POULTRY HOUSE

2 square feet per bird, depending, as does also the glass area, upon the size, location, and style of the poultry house.

Do not place openings where they are likely to produce a draft on the roosts, or where sunlight through them will fall upon the roosts, as this would tend to cause the birds to sun themselves idly on the roosts.

7. *Roof.* By the pitch of a roof is meant the rise divided by the span. (See Fig. 197.) If the roof has less than ⅓ pitch, shingles will not prove satisfactory. Prepared roofing or tar-paper is better. Fasten the same with roofing tacks and make the joints waterproof with asphalt or with roofing cement. Fig. 195 illustrates various types of roofs that are used for poultry houses.

FIG. 80. CLASS AT BELTON, MO., BUILDING A "MISSOURI" TYPE POULTRY HOUSE

Mr. Campbell, instructor. Photograph, courtesy of Mr. W. T. Spanton, State Supervisor of Agricultural Education.

8. *Fixtures.*

a. *Roosts.* Roosts should be about 2″ in diameter. Strips of 2″ × 2″ material can be used or 2″ × 4″ pieces can be set edge-

wise. In either case the surface should be smooth and the corners should be rounded off about ¼″.

Place the roosts so that they are level and firm. They should be 14″ from the back wall, 12″ apart, and from 3′ to 5′ from the

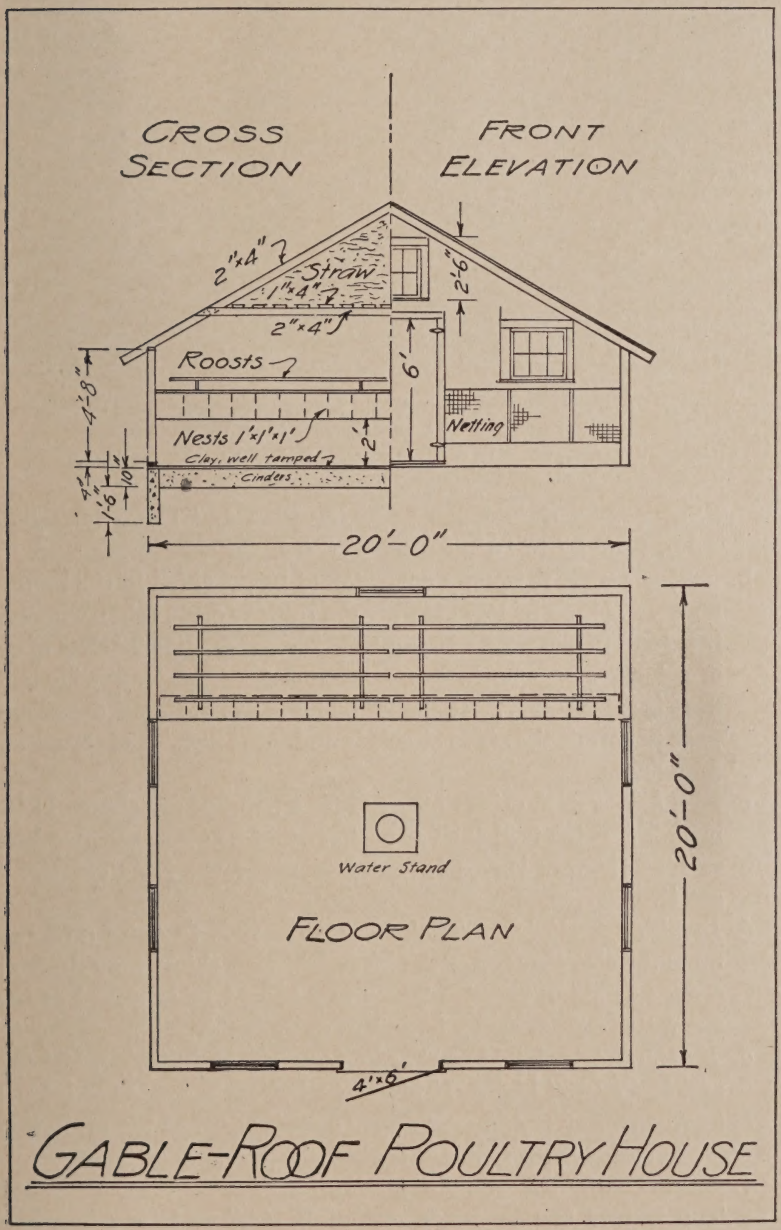


FIG. 81. GABLE-ROOF POULTRY HOUSE

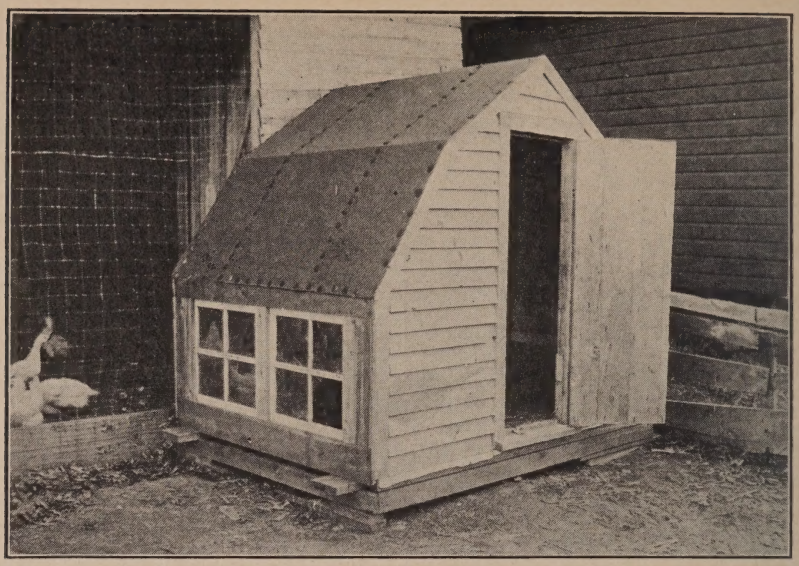


FIG. 82. A POULTRY HOUSE BUILT OF TWO PIANO BOXES AND SOME WASTE SIDING AT CHIPPEWA FALLS, WIS.

Photograph, courtesy of Mr. G. W. Gehrand, State Supervisor of Agricultural Education, Madison, Wis.

floor. They should not be closer than 14″ from the ceiling. Allow from 8″ to 14″ of roost per bird.

b. *Broody coop.* A broody coop should be provided in the poultry house. It may be located near the back or on the side, wherever it is least in the way. It can be made out of 1″ × 2″ slats or out of netting with a bottom of wooden slats. A coop 2′ wide by 3′ deep is satisfactory. It should be hung or placed off the ground so as to permit the air to circulate under the hen. This breaks up broodiness.

c. *Feed hoppers.* Various forms of feed hoppers are shown in this book. Scratch feed such as grain should be strewn among litter such as straw or leaves in order to make the hens exercise to get it.

d. *Drinking fountains.* Their design depends to quite an extent upon the size and age of the birds. Young chicks may drown in a deep drinking vessel. The vessel should be arranged so that the water cannot easily be spilled or polluted.

e. *Nests.* Nests should usually be from 10″ to 12″ wide, 12″ deep and 10″ or 12″ high. It is not well to make nests too large as two hens may try to crowd into a single nest at the same time. Hens prefer nests that are darkened.

f. *Muslin curtains.* A light grade of unbleached muslin is best. The frames can be made out of 1″ × 2″ or 1″ × 3″ material depending upon the size of the curtain. Hinge the curtains

from the top and draw them up and down with a piece of clothesline running over a pulley.

The method of fastening the corners of curtain frames is the same as that illustrated for window screens, Fig. 206. It is better to make two or more separate curtains than a single curtain that is much larger than $4' \times 5'$ as the frames are likely to get racked or broken if they are too large.

g. *Doors.* Outside doors should open outward. If interior doors are used, hang them 12″ or 14″ from the floor so that they will clear straw or other litter.

FIG. 83. POULTRY HOUSE

Constructed almost entirely by pupils at Murphysboro, Ill., for egg-laying contest started by the high-school class. Over 100 pure-bred hens were entered in the contest. Photograph, courtesy of Carl Colvin, State Supervisor of Agricultural Education.

A standard-sized door is 2′ 6″ × 6′ 8″. The door of the poultry house does not always need to be that large. Sometimes the door may want to be wider so that a wheelbarrow or other objects can pass through it.

If the door is to be home-made, place the cross-strips so that the hinges will catch it. The top hinge should be so placed that there are 5″ or 6″ from the top of the door to the top of the hinge. The upper edge of the lower hinge should be about 10 inches from the bottom of the door.

The Shed-Roof, Open Type, of Laying House

1. *Description.* By open type is meant a house having a relatively large opening which is closed only when necessary by means of muslin curtains or glass. This type of house is very popular among poultrymen in the North Atlantic States as well as elsewhere. Fig. 79 shows such a house. The working drawings and specifications relating to this poultry house are adapted from Bulletin 325, entitled "Poultry Buildings," issued by H. R. Lewis, Professor of Poultry Husbandry at the New Jersey Agricultural Experiment Station.

The house is planned for the average farm flock. The house is 12′ wide, 14′ deep, and has a capacity of from forty to fifty birds.

2. *Lumber required.* Hemlock, yellow pine, Douglas fir, etc.

No. of Pieces	Dimensions	Purpose
2	4″ × 4″ × 14′	Sills
2	4″ × 4″ × 12′	Sills
4	2″ × 4″ × 12′	Plates
2	4″ × 4″ × 14′	Posts
6	2″ × 4″ × 14′	Studding
7	2″ × 4″ × 16′	Rafters
1	2″ × 4″ × 14′	

500 sq. ft. 8″ shiplap for roof boards, doors, and interior fixtures.
300 sq. ft. novelty siding.
60 lineal ft. 1″ × 3″ white pine, cypress, or fir for curtains or trim.
30 lineal ft. 1″ × 3″ white pine, cypress, or fir for trimming.

3. *Approximate cost of materials* (1919 figures).

Lumber	$36.00
Roofing, 300 sq. ft.	9.00
Glass, 2 sash 3′ × 5′, each	4.00
Muslin, wire netting, hinges, nails and other hardware	3.18
Concrete for floor and foundation —	
cement 10 bags	5.00
cinders, 7 cu. yds.	7.00
sand, 1 cu. yd.	1.50
Total cost	$65.68

The Gable-Roof, Square Plan Type of Laying House

A typical poultry house of this type is illustrated in Circular No. 80, of the Missouri Agricultural Experiment Station, by H. L. Kempster, Professor of Poultry Husbandry. The plans and the description given

herewith are adapted from the above bulletin. Fig. 80 shows this type of poultry house in process of construction.

1. *Description.* The working drawing given herewith shows the general arrangement. An unusual feature is found in the arrangement of the straw-filled attic and the distance above the ceiling joists or collar-beams. The foundation is of concrete, and the floor is made of well-tamped clay over a bed of cinders. Where cinders cannot be obtained stone should be substituted.

   The capacity of the house is from 120 to 175 hens. The cost on the basis of pre-war prices is about $120.

2. *Material required.*[1]

Use	Pieces	Size	Grade	Board Feet	Cost	Total
Rafters	22	2 × 4–12	1	176	$2.50	$4.40
Plates and sills	8	2 × 4–20	1	107	2.50	2.68
Studding and framing	1	2 × 4–10	1	7	2.50	.18
Framing	19	2 × 4–16	1	203	2.50	5.08
Roosts	5	2 × 4–20	1	74	2.50	1.85
Finishing	6	1 × 4–10	2	20	2.00	.40
Finishing	1	1 × 4–16	2	6	2.00	.12
Finishing	4	1 × 4–10	2	14	2.00	.28
Finishing	8	1 × 4–12	2	32	2.00	.64
Floor for loft	52	1 × 4–14	2	260	2.00	5.20
Sides, car siding	..	1 × 6–10	..	600	2.00	12.00
Roof and droppings platform, shiplap	..	1 × 8–12	..	720	2.25	16.20
Shingles	..	..	..	5⅓M	3.00	16.50
Sashes	7	6 light 8 × 10	..	..	.60	4.20
Front and over-windows, wire netting	..	3 × 32	..	..	.04	1.28
Hinges	1 pair	..	..	..	.10	.10

Materials excluding nails and foundation	$ 71.11
Labor	28.28
Foundation, 3 cubic yards at $6	18.00
Total	$117.39

The Piano Box Poultry House

An example of an inexpensive poultry house is shown in Fig. 82 which was built at Chippewa Falls, Wisconsin, by boys studying agriculture.

A similar house is shown in Bulletin No. 10, 1915–16, entitled "Piano Box Hen House," issued by the Extension Department of the Ohio State University. The following bill of material is taken from this bulletin. It is based on pre-war prices.

Bill of material

2 piano boxes	$3.00
2 rolls 1-ply roofing paper	3.50
1 piece 2″ × 4″ × 12′ Y.P.) 1 piece 2″ × 4″ × 16′ Y.P. } Sills 1 piece 2″ × 4″ × 8′ Y.P.)	.62

[1] From Circular 80, *The Missouri Poultry House*, Agricultural Experiment Station, Columbia, Missouri.

1 piece 1″ × 12″ × 12′, No. 1 Y.P., Brace	.32
1 piece 1″ × 12″ × 8′ } Doors	.52
2 pieces 1″ × 4″ × 12′ }	
2 pounds seven-penny box nails	.06
1 pound eight-penny wire nails	.04
1 pound sixteen-penny wire nails	.05
1 pair 5-inch T hinges	.10
1 piece poultry netting 2′ × 2′ 6″	.10
	$8.31

REFERENCES

1. *Free bulletins.*

Chicken Houses. Sherwood, Ross M. Circular No. 61, 1917, Agricultural Experiment Station, Kansas.

Colony Brooder Houses. Philips, A. G., and Jones, L. L. Extension Circular No. 52, 1919, Department of Agriculture, Purdue University, Lafayette, Ind.

Farm Poultry. Crooks, F. D. Extension Circular No. 47, Agricultural Experiment Station, State College, Pa.

Farmers' Bulletin 574, 1918. United States Department of Agriculture.

Farmers Poultry House, The. Kempster, H. L. Circular 75, 1915. Agricultural Experiment Station, Columbia, Mo.

Housing Farm Poultry. Philips, A. G. Circular No. 98, 1920. Agricultural Experiment Station, Purdue University, Lafayette, Ind.

Missouri Poultry House, The. Kempster, H. L. Circular 80, 1916. Agricultural Experiment Station, Columbia, Mo.

Natural and Artificial Brooding of Chickens. Lamon, H. M. Farmers' Bulletin 624, 1915.

Piano Box Hen House. Jacoby, F. S. Extension Bulletin No. 10, Ohio State University.

Poultry Buildings. Lewis, H. R., and Thompson, W. C. Bulletin 325. Agricultural Experiment Station, New Brunswick, N.J.

Poultry House Construction. Jones, R. E., and Card, L. E. Bulletin 81, 1915. Agricultural Experiment Station, Storrs, Conn.

Poultry House Construction. Lee, Alfred R.

Poultry House Equipment. Philips, A. G., and Jones, L. L. Extension Bulletin 57, 1919. Purdue University, Lafayette, Ind.

Poultry Notes. Pearl, Raymond. Bulletin No. 216, 1913. Agricultural Experiment Station, Orono, Maine.

Poultry Projects. Werner, John C. Extension Circular No. 4. Kansas State Agricultural College, Manhattan.

Practical and Inexpensive Poultry Appliances. Dougherty, J. E., and Lloyd, W. E. Circular No. 142. Agricultural Experiment Station, University of California, Berkeley, Cal.

Rearing Chickens, Brooder House Construction. Hurd, L. M., and Buchanan, H. P. Lesson 130, 1917, Cornell Reading Course, Cornell University, Ithaca, N. Y.

Records from a Purdue Farm Flock. Philips, A. G. Bulletin, 211, 1918. Agricultural Experiment Station, Purdue University, Lafayette, Ind.

Standard Poultry Houses. Lewis, H. R., and Thomspon, W. C. Circular 115. Agricultural Experiment Station, New Brunswick, N. J.

Successful Iowa Shed Roof Poultry House. (A). Turpin, George M., and Costello, M. F. P. Bulletin No. 176, 1918. Agricultural Experiment Station, Ames, Iowa.

2. *Text or reference books.*

Lewis, H. R. *Productive Poultry Husbandry.* J. B. Lippincott Co., 1919 (third edition).

Robinson, John Henry. *Principles and Practice of Poultry Culture.* Ginn and Co.

CHAPTER VII

RELATING TO FIELD CROPS

THE projects given in this chapter are such as are used in connection with growing or harvesting the common field crops. Other projects related to this as well as to other phases of agriculture, as, for example, the construction or repair of fences, gates, wagon boxes, wagon jacks, and drag sleds, are found in the chapter dealing with "general" projects.

Seed Potato Tray

1. *Purpose.* A convenient and very satisfactory way to store seed potatoes is in trays. (See Fig. 85.) This tray is of convenient size for handling and is made in such a way as to insure good ventilation.
2. *Material required.*
   a. *Lumber.* Cypress and cedar are especially good for this purpose, but other woods may be used.

No. of Pieces	Dimensions	Purpose
2	$13/16'' \times 3\frac{3}{4}'' \times 30\frac{1}{2}''$	Sides
2	$13/16'' \times 3\frac{3}{4}'' \times 14\frac{3}{8}''$	Ends
4	$1\frac{3}{4}'' \times 1\frac{3}{4}'' \times 6''$	Posts
14	$1'' \times 1'' \times 16''$	Laths for bottom

   b. *Hardware.*
      1/10 lb. 3d. common wire nails.
      1/8 lb. 6d. common wire nails.
      1 lb. 6d. finishing nails.
3. *Directions.*
   a. As most of the strain comes upon the posts, they should be nailed securely.
   b. Lumber ½″ thick may be substituted for the $13/16''$ material used in the ends and sides. Crating material can serve the purpose.

Potato Crate

1. *Purpose.* Potato crates offer several advantages. They may be used to advantage as lug or field boxes and later as storage crates. They are made of box or crating material and will hold one bushel.
2. *Material required.*
   a. *Lumber.* Any available medium or low priced lumber.

No. of Pieces	Dimensions	Purpose
4	$13/16'' \times 1'' \times 12''$	Uprights
10	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 19''$	Sides
5	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 17''$	Bottom
10	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 13''$	Ends

   b. *Hardware.* ½ lb. 4d. common wire nails.

3. *Directions.*
   a. While ½″ lumber is specified, there may be opportunity to use ¼″ or ⅜″ lumber instead.
   b. Nail up the ends first; next nail the sides to the ends, and complete the crate by nailing on the bottom slats.

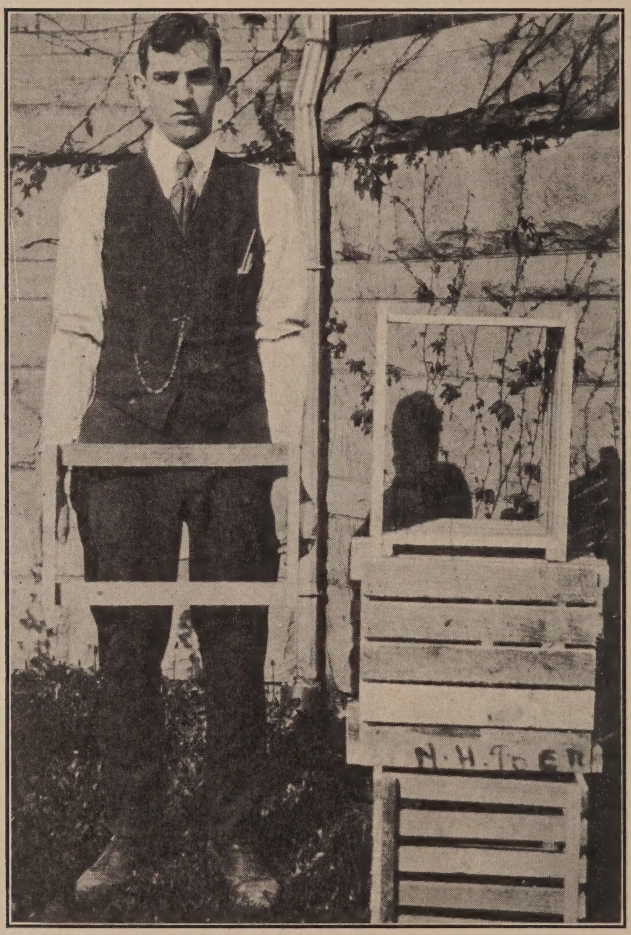


FIG. 84. POTATO CRATE

Capacity one bushel. Made by the boys in the Edinboro, Pa., Vocational School, under the direction of J. D. McVean, Supervisor of Agriculture. Photograph, courtesy of Mr. J. D. McVean.

Seed Corn Storage [1]

A. Electrically welded fencing.

Several good methods of storing seed corn are shown in Figs. 86, 87, and 88.

The first of these is by means of electrically welded fencing wire.

[1] See Farmers' Bulletin 1175. Also Extension Circular 2, New Jersey State Agricultural College.

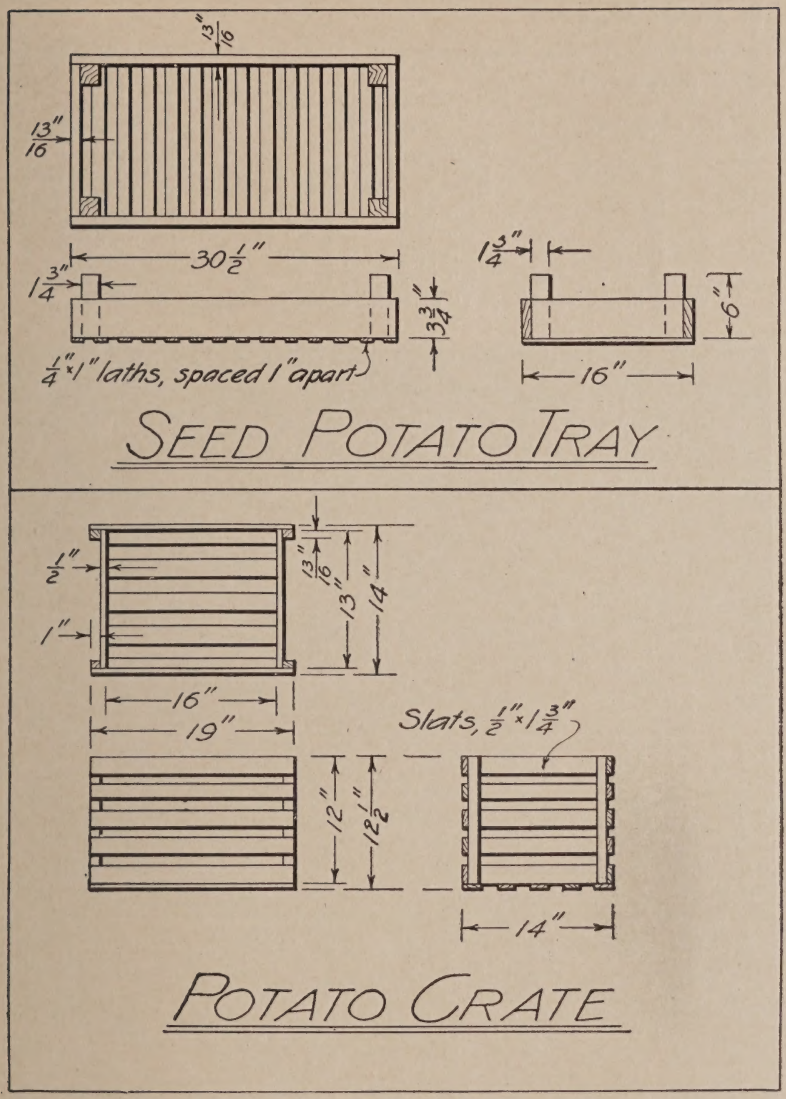


FIG. 85. SEED POTATO TRAY, AND POTATO CRATE

Such fencing material, having wires 4″ apart vertically and 2″ apart horizontally, is recommended. The method of cutting such fencing is shown in Fig. 86. The fencing wire may be suspended from rafters so that mice and rats cannot get at the corn. The cost of the wire is very nominal, and the racks may be used for a number of years.

B. Mouse-proof seed corn crate.

1. *Purpose.* Seed corn may also be stored to advantage in a simple crate such as shown in Fig. 87. This may be made in any desired size.

2. *Material required.*

a. *Lumber.* Any sound lumber of proper dimensions will serve the purpose.

No. of Pieces	Dimensions	Purpose
2	$13/16'' \times 8'' \times 2'\ 6''$	Bottom
2	$13/16'' \times 1\frac{3}{4}'' \times 16''$	Lower end cleats
2	$13/16'' \times 1\frac{3}{4}'' \times 15''$	Upper end cleats
8	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 10\frac{7}{16}''$	Uprights
2	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 2'\ 6''$	Sides of box
2	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 2'\ 6''$	Sides of lid
2	$\frac{1}{2}'' \times 1\frac{3}{4}'' \times 16''$	Ends of lid

8 lineal feet $\frac{1}{2}'' \times 1''$ material to hold netting to lid.

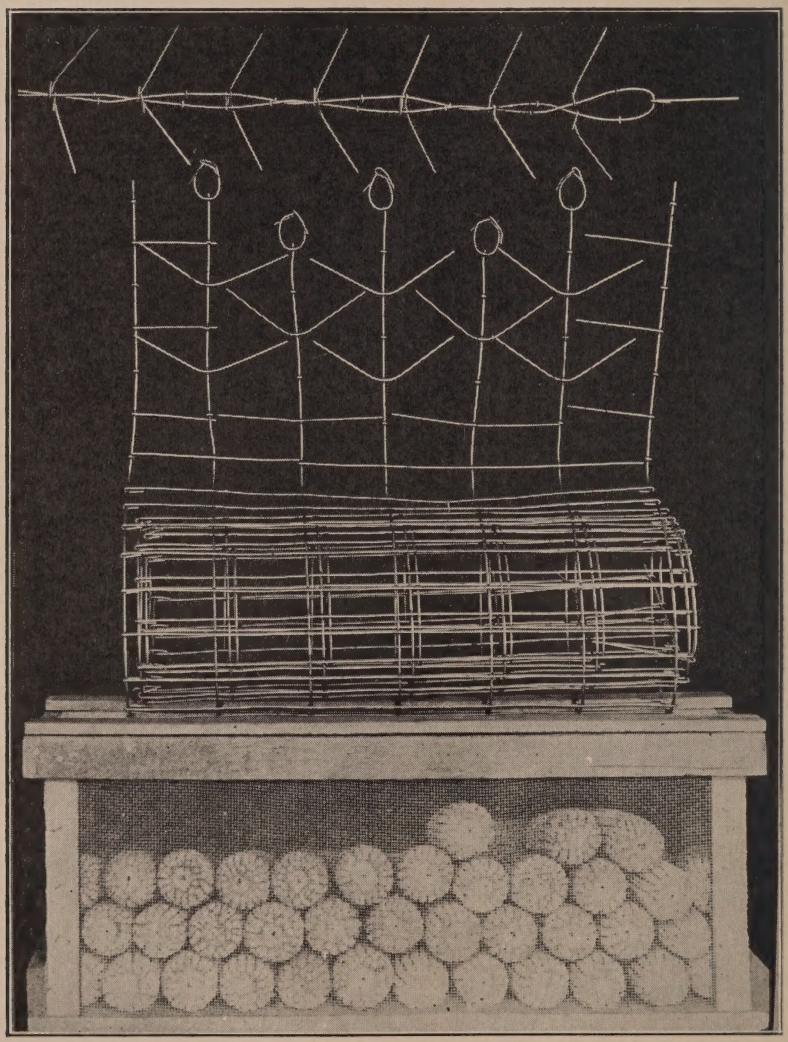


Fig. 86. Wire Rack, and Mouse-Proof Crate for Storing Seed Corn

See Farmers' Bulletin No. 1175, entitled "Better Seed Corn." Photograph shown through the courtesy of Mr. C. P. Hartley, in charge of corn investigations, Bureau of Plant Industry, U.S. Department of Agriculture, Washington, D.C.

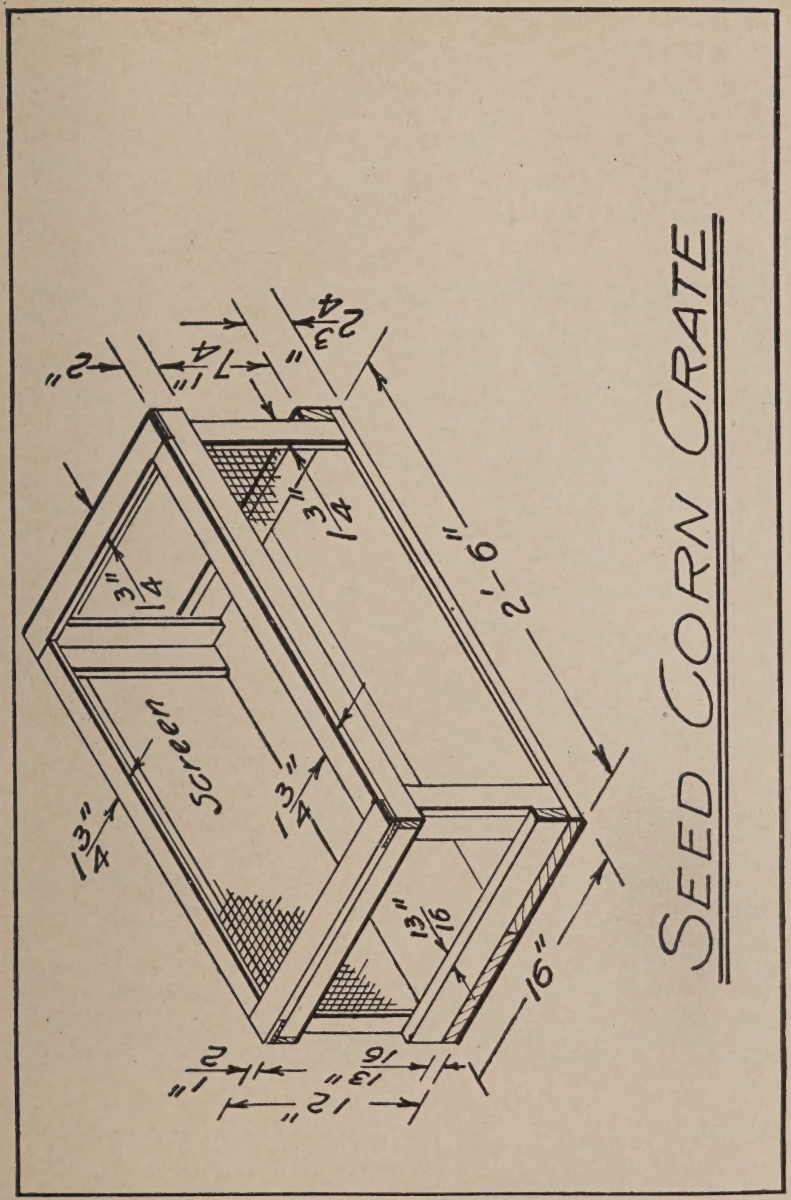


FIG. 87. SEED CORN CRATE

b. *Hardware.*

2 pieces 16″ × 2′ 6″ ¼″ sq. mesh galvanized hardware cloth.
2 pieces 12″ × 2′ 4″ ¼″ sq. mesh galvanized hardware cloth.
2 pieces 12″ × 16″ ¼″ sq. mesh galvanized hardware cloth.
¼ lb. ½″ galvanized wire staples.
⅛ lb. 3d. common wire nails.
1/10 lb. 4d. finishing nails.
1 dozen 6d. finishing nails

3. *Directions.*
   a. Use hardware cloth or else wire mosquito netting to cover the crate. Such covering should also be put over the bottom, either inside or outside of the crate.
   b. The corners of the lid are fastened together by means of half-lap joints, and are reënforced by the ½″ × 1″ strips that hold the netting to the lid.

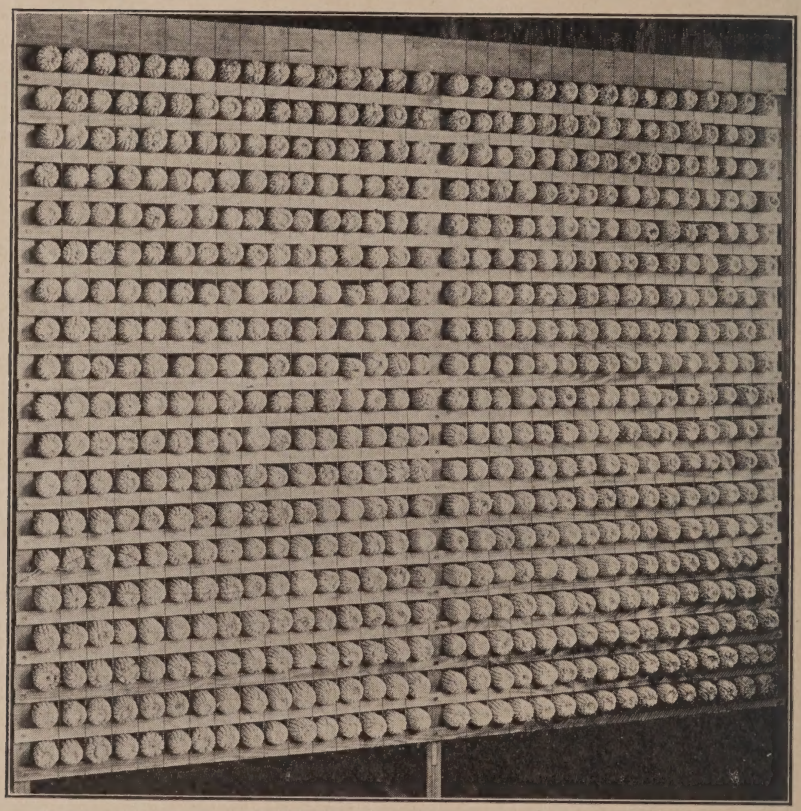


FIG. 88. SEED CORN CURING FRAME

See Farmers' Bulletin No 1175, entitled: "Better Seed Corn." Photograph shown through the Courtesy of Mr. C. P. Hartley, in charge of corn investigations, Bureau of Plant Industry, U.S. Department of Agriculture, Washington, D.C.

Seed Corn Rack

1. *Purpose.* The seed corn rack shown in Fig. 89 is one that is used for drying and storing seed corn, and to store seed corn that is being tested for germination. The rows in the rack may be numbered to correspond with rows in the germination box.
2. *Material required.*
   a. *Lumber.* Yellow pine, fir, cypress, etc.

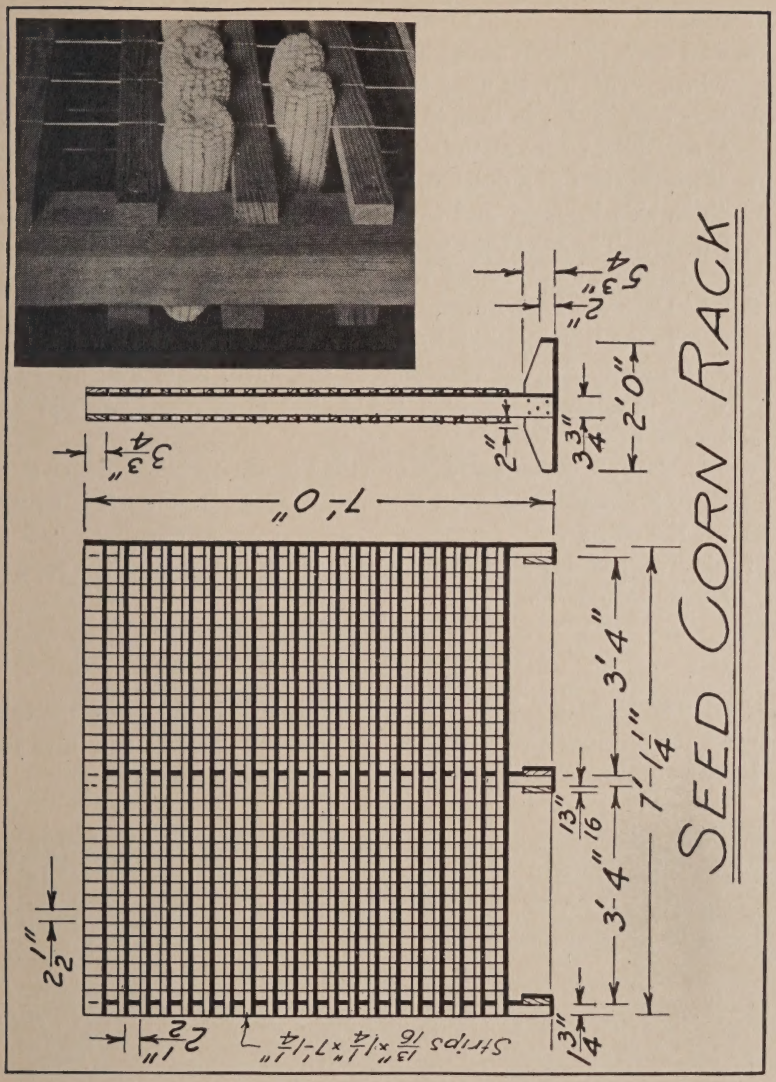


FIG. 89. SEED CORN RACK

NO. OF PIECES	DIMENSIONS	PURPOSE
3	1¾" × 3¾" × 7'	Posts
4	13/16" × 5¾" × 2'	Feet
38	13/16" × 1¼" × 7' 1¼"	Slats
2	13/16" × 3¾" × 7' 1¼"	Top boards

b. *Hardware.*

400 lineal feet of galvanized iron wire about 1/16" diameter.

½ lb. ⅝" galvanized wire staples.

1 gross 1½" No. 10 flat head bright screws, or else 1½ lbs. 6d. finishing nails.

3. *Directions.*
   a. Saw kerfs ⅛″ deep are to be cut into all the slats for the vertical wires. This can be done to best advantage in a miter box.
   b. Saw off one slat so that the wires will come 2½″ apart except at the middle, where allowance is made for the upright post.
   c. With this slat as a pattern, mark the others, lay six or a dozen of them side by side, and square the lines across with a framing square. They are then ready to cut in the miter box. A home-made box is good enough for the purpose. (See Index.)
   d. The slats are kept from sagging by fastening the vertical wires first to the 1³⁄₁₆″ × 3¾″ boards at the top of the rack, and then by occasionally driving staples into the lower slats and over the wires in such a way that the weight is carried from the top boards of the rack.
   e. The slats are either screwed or nailed to the upright posts so as to leave 2½″ spaces between them. This makes spaces 2½″ square for the corn.
   f. Slats and wires are fastened on the front and back of the rack as shown in Fig. 89.

Plank Drag

1. *Purpose.* A plank drag such as shown in Fig. 90 is extensively used by farmers and gardeners in preparing seed beds, and for leveling and compacting soil when necessary.

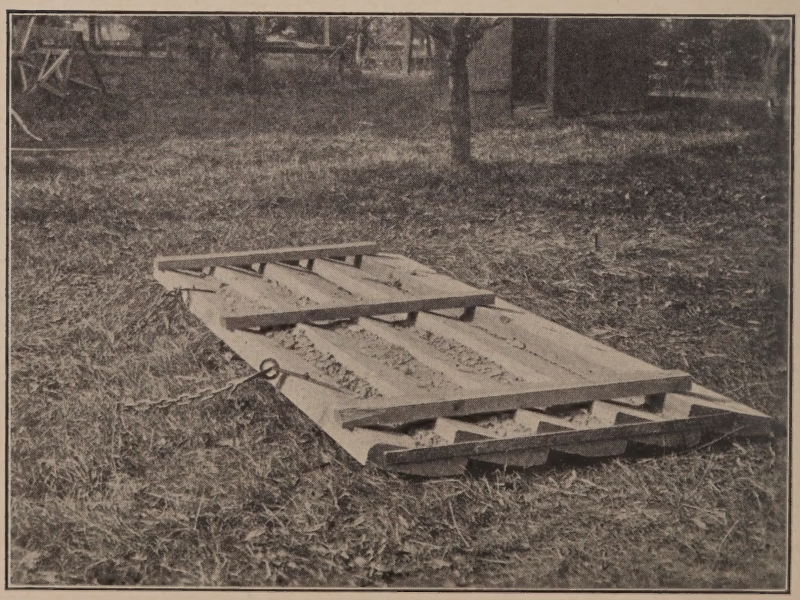


FIG. 90. PLANK DRAG USED AT THE PENNSYLVANIA STATE COLLEGE

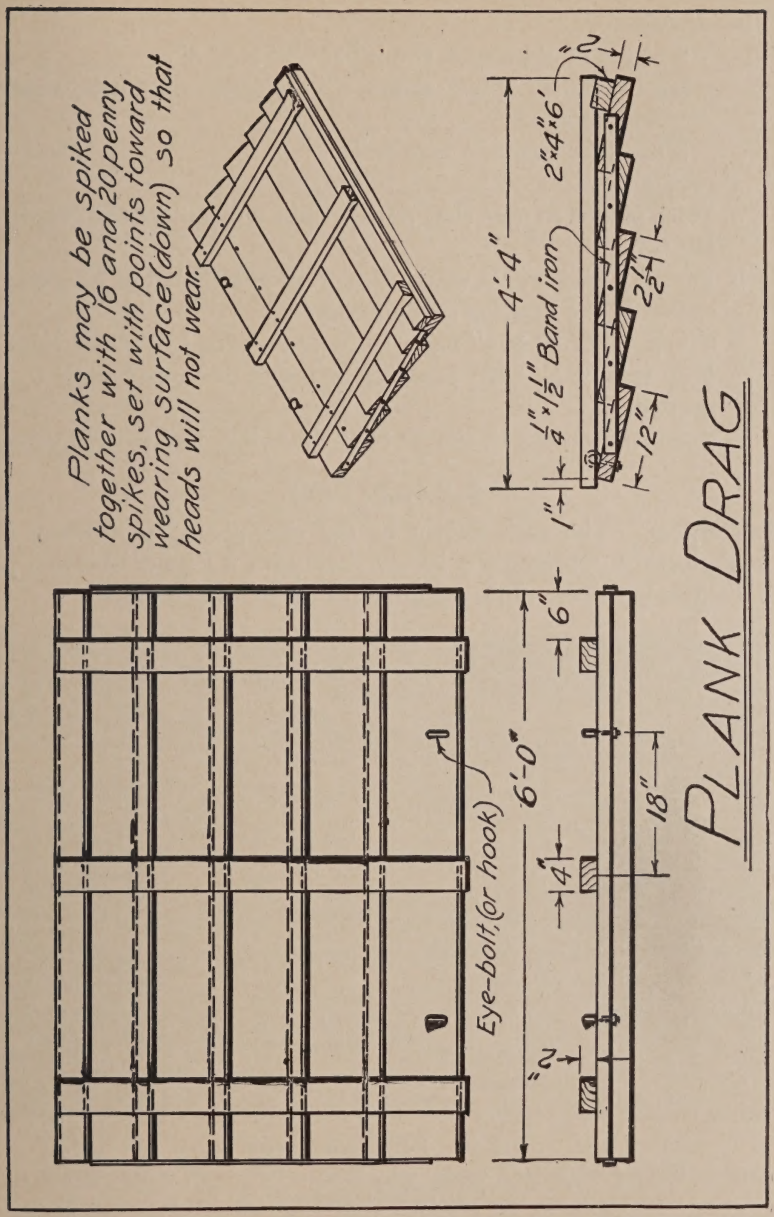


FIG. 91. PLANK DRAG

2. *Material required.*

a. *Lumber.* A good wearing wood such as oak, chestnut, maple, or yellow pine is to be preferred.

No. of Pieces	Dimensions	Purpose
5	2″ × 12″ × 6′	Planks
3	2″ × 4″ × 4′ 4″	Cleats
1	2″ × 4″ × 6′	Support

b. *Hardware.*

2 pieces of old wagon tire ¼″ × 1½″ × 3′ 8″.

2 eyebolts ½″ × 2½″ shank, 1″ diameter ring with washers and nuts.

3 lbs. 16d. common wire nails.

3. *Directions.*

a. Place planks so that they lap 2½″ and spike them together from the top.

b. Fasten a piece of old wagon tire or other steel bar at each end as shown in the drawing and photograph.

c. The piece of 2″ × 4″ material placed on the last plank helps to keep this plank from breaking or losing its proper angle to the ground.

d. Spike the planks to the 2″ × 4″ cross-ties, and insert eyebolts.

Soil Crops Rack

1. *Purpose.* The rack shown in the accompanying drawing and photograph represents a handy rack with a "solid" bottom and detachable sides. It is designed for various soil crops.

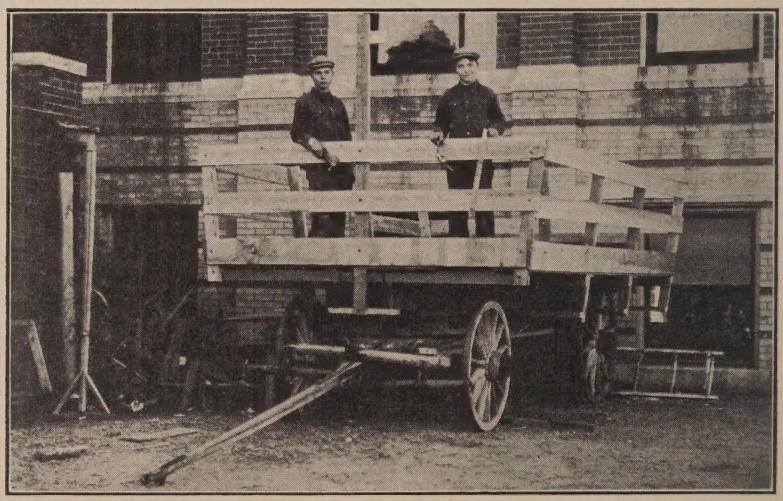


FIG. 92. SOIL CROPS RACK

Built by Paul and Ethan Horst, Garden City, Kansas. Photograph, courtesy of Wm. R. Curry, Topeka, Kansas.

2. *Material required.*

a. *Lumber.* Yellow pine, Douglas fir, or cypress.

NO. OF PIECES	DIMENSIONS	PURPOSE
2	2″ × 4″ × 3′ 10″	Posts
6	2″ × 4″ × 4′ 6″	Posts
1	2″ × 4″ × 8′ 6″	Posts
1	2″ × 4″ × 12″	Foot rest
4	2″ × 4″ × 18″	Cross-ties under sills

No. of Pieces	Dimensions	Purpose
2	2″ × 10″ × 13′ 6″	Sills
4	2″ × 4″ × 7′	Cross sills
3	2″ × 4″ × 6′ 9″	Cross-ties
4	1″ × 6″ × 8′	End boards
2	1″ × 6″ × 7′ 6″	End boards
4	1″ × 6″ × 14′	Side boards
2	1″ × 8″ × 14′	Side boards
7	1″ × 12″ × 13′ 10″	Flooring

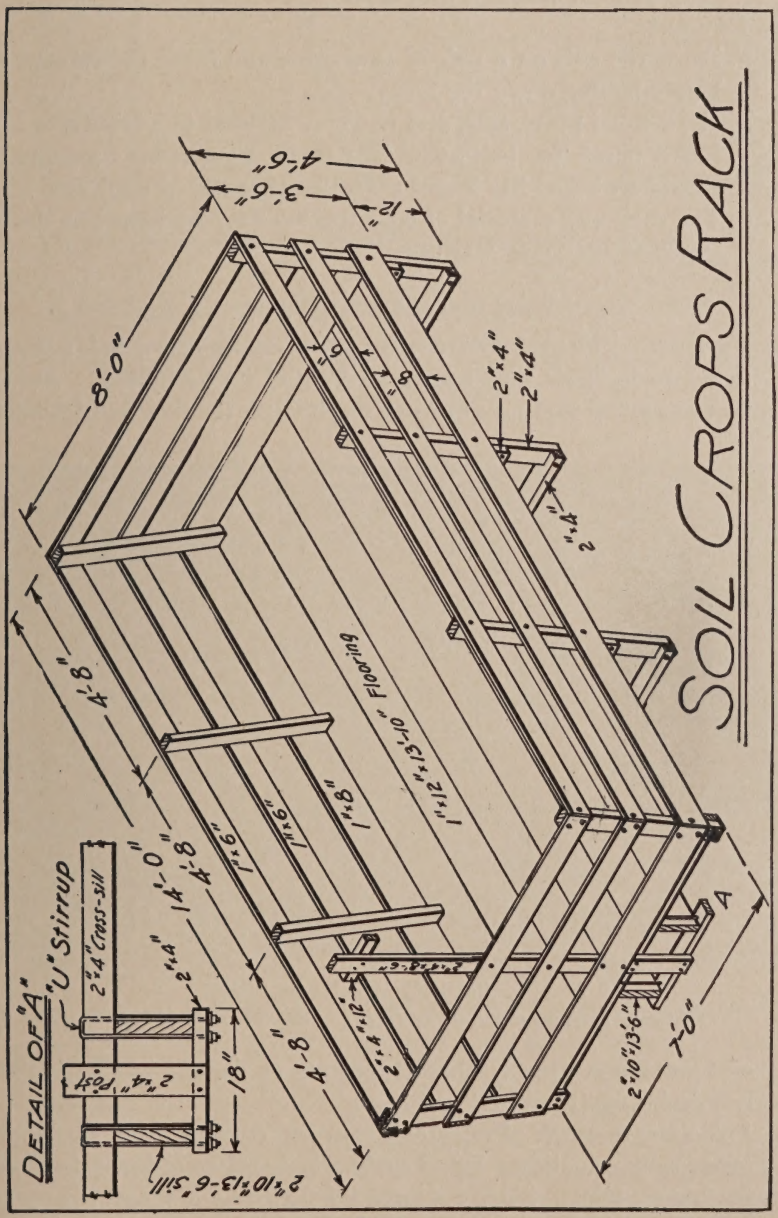


Fig. 93. Soil Crops Rack

b. *Hardware.*

8 stirrups as per drawing.
2 doz. ¼″ × 6″ carriage bolts with washers.
28 ¼″ × 3½″ carriage bolts with washers.
20 ¼″ × 4½″ carriage bolts with washers.
4 ¼″ × 6½″ carriage bolts with washers.
1½ lbs. 8d. common wire nails.

3. *Directions.*

a. Place the sills on a pair of sawhorses and erect the framework before nailing down the floor.
b. Hard wood posts, sills, and ties may be used to advantage.
c. Holes bored for bolts that are to be withdrawn occasionally should be bored 1/16″ larger than the diameter of such bolts.
d. The rack and material of construction may be varied in size as circumstances may warrant.

Seed Potato Cutting Rack

1. *Purpose.* The seed potato cutting rack shown herewith is a simple home-made affair that has demonstrated its usefulness. Almost twice as many seed potatoes can be cut with the rack as without it,

FIG. 94. SEED POTATO CUTTING RACK
Photograph, courtesy of Mr. Daniel Dean, Riverdale Farms, Nichols, N.Y.

and yet the cutting is "hand" cutting as distinguished from the less desirable "machine" cutting.

2. *Principles involved.* Proper selection and cutting of the seed mean increased production. Hand cutting is therefore to be preferred to machine cutting. Since the knife is held firmly in place, the opera-

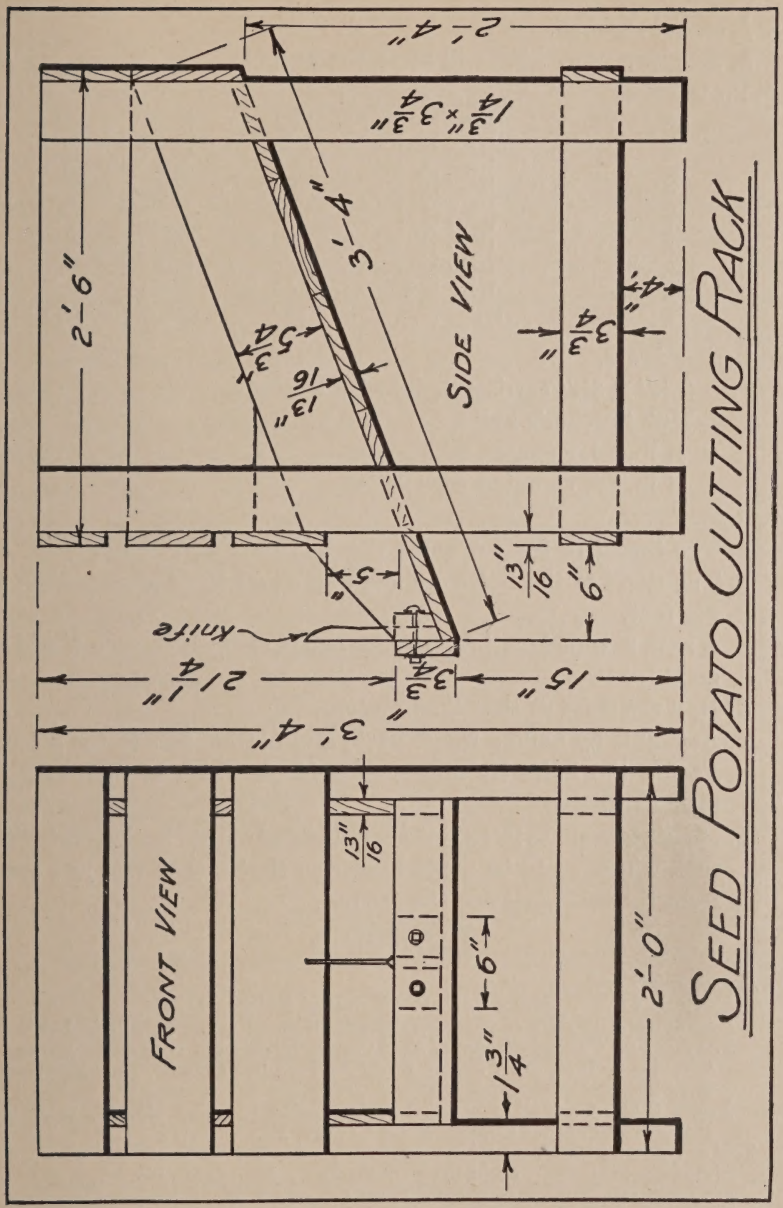


FIG. 95. SEED POTATO CUTTING RACK

tor can use both hands to draw the seed across the knife so that each piece will have the proper size and number of eyes.

In order to prevent the spread of Fusarium wilt and other diseases affecting potatoes, the knife is disinfected occasionally, and always after cutting a potato with dark spots or streaks in the flesh. A good disinfectant is made of two large teaspoonsful of formalin to one pint of water. This is applied to the knife with a rag or sponge.

3. *Material required.*

a. *Lumber.* Any kind will serve the purpose.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 3'\ 4''$	Legs
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 2'$	Lower braces
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 2'\ 6''$	Lower braces
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 3'\ 4''$	Sloping arms
5	$1\frac{3}{16}'' \times 9\frac{3}{4}'' \times 21\frac{1}{2}''$	Bottom
1	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 21\frac{1}{2}''$	Front
5	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 2'$	Front and back
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 2'\ 6''$	Sides
2	$1\frac{3}{16}'' \times 10'' \times 2'\ 6''$	Sides
1	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 6''$	Block for knife

b. *Hardware.*

2 ¼″ × 3½″ carriage bolts with washers.

1 6″ butcher's knife.

½ lb. 6d. common wire nails.

½ lb. 8d. common wire nails.

4. *Directions.*

a. The throat or front opening should be about 5″ high.

b. The slope of the bottom should be equal to or greater than 4″ per foot.

c. A rack 2′ wide is satisfactory for one person, and a rack 4′ wide is good for two.

d. Nail the sides so that they match.

e. Assemble by nailing front, back, and bottom fast to the sides.

f. Fasten the knife by means of a block which is tightened by means of bolts.

g. If potatoes are to be cut into bags instead of into bushel crates, the rack will need to be made higher so that a sack will just reach from the cross-arms to the ground.

REFERENCES

1. *Free circulars and bulletins.*

Better Seed Corn. Hartley, C. P. Farmers' Bulletin 1175.

How to Grow an Acre of Potatoes. Stuart, Wm. Farmers' Bulletin 1190.

The Need for Careful Storage of Seed Corn. Division of Extension, Extension Circular 2, 1918, New Jersey State Agricultural College, New Brunswick, N.J.

Potato Culture. Noll, Charles F. Extension Circular No. 45, 1916, The Pennsylvania State College, State College, Pa.

2. *Text or reference books.*

Livingston, George, *Field Crop Production.* Macmillan Co.

Montgomery, E. G. *Productive Farm Crops.* J. B. Lippincott Co.

Wilson, A. D., and Warburton, C. W. *Field Crops.* Webb Co.

CHAPTER VIII

RELATING TO HORTICULTURE

HORTICULTURE is carried on in all sections of the United States. In some States, it is carried on as a highly developed enterprise. Too frequently it does not receive the attention necessary to insure success. A more general culture of fruits in the home gardens, and in orchards, coupled with better methods and care, will amply repay effort expended in terms of pleasure and health, and will prove profitable from an economic standpoint as well. The projects offered in this chapter are such as will assist the farmer and fruit-grower in caring for berries and fruit trees.

Planting orchards. Two systems of planting orchards are in common use, the "square" system, and the "diagonal" or equilateral triangle method. In planting large orchards, the latter method will allow about 15 per cent more trees to the acre than the square method of planting.

The following distances are considered satisfactory in many localities. Sometimes special conditions, as lack of moisture, excessive sunlight, or special methods of cultivation or harvesting, make variations from these distances desirable.

TABLE 12. DISTANCES FOR FRUIT TREES

KIND OF TREE	DISTANCE REQUIRED	KIND OF TREE	DISTANCE REQUIRED
Apple	32 to 50 feet	Apricot	15 to 24 feet
Pear (standard)	20 to 30	Cherry (sweet)	25 to 40
Pear (dwarf)	10 to 20	Cherry (sour)	18 to 24
Peach	15 to 24	Quince	10 to 20
Plum	15 to 24		

The Planting Board

1. *Purpose.* The planting board is a simple device that is of assistance in placing shrubs or trees in a given exact position. In laying out orchards, for example, stakes are usually driven where the trees are to go. When the hole is to be dug, the planting board is placed so that the notch fits around the stake representing the tree. Two other stakes are placed at the ends of the board (Number 2). The board is then removed, the central stake is withdrawn, and the hole is dug. When the tree is to be planted, the board is again placed in position over the end guide stakes and the tree takes the place of the central peg as shown in Fig. 96.
2. *Material required for planting board Number 1.*
   a. *Lumber.* White pine, cypress, or Douglas fir.

NO. OF PIECES	DIMENSIONS	PURPOSE
1	$13/16'' \times 9\frac{3}{4}'' \times 14''$	Top
1	$13/16'' \times 9\frac{3}{4}'' \times 10''$	Top (hinged part)
3	$\frac{7}{8}'' \times \frac{7}{8}'' \times 6''$	Pegs

FIG. 96. USING A PLANTING BOARD AT THE PENNSYLVANIA STATE COLLEGE

b. *Hardware.* 2 "T" hinges or strap hinges with screws.

3. *Directions.*
   a. Locate the positions of the holes for the three pegs, and bore the holes before cutting the board for length.
   b. A piece of broom- or hoe-handle may be used for the pegs.
   c. Finish, if desired, with boiled linseed oil, or with paint.
4. *Material required for planting board Number 2.*
   a. *Lumber.* Cedar, cypress, pine, or other wood.

NO. OF PIECES	DIMENSIONS	PURPOSE
1	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 5'\ 0''$	Board

5. *Directions.* Cut the board as shown. Smooth up on all sides and finish with linseed oil or paint if desired.

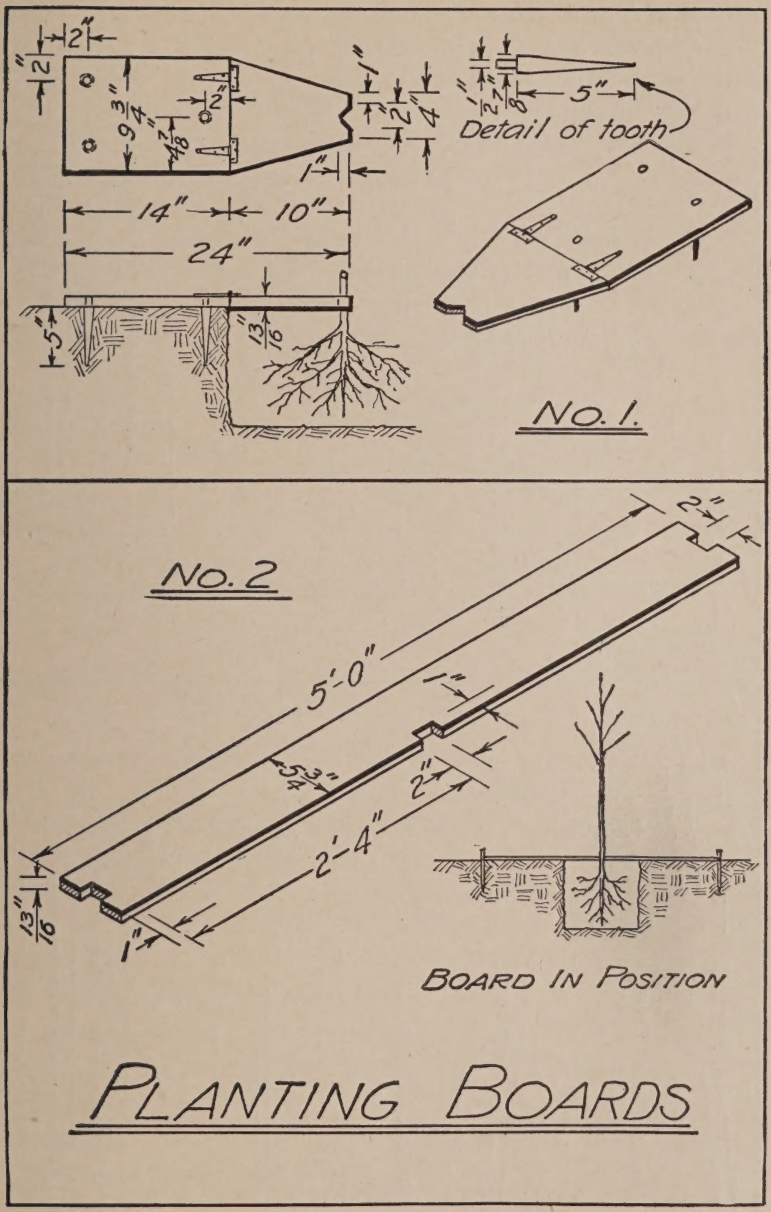


FIG. 97. PLANTING BOARDS

Berry Carrier

(For strawberries)

1. *Purpose.* Strawberries, gooseberries, and currants may be picked directly into the small boxes in which they are sold, by means of the carrier shown in Fig. 98 "A." This type of carrier is extensively

used in fruit sections of the United States. It has a thin "solid" bottom which tends to keep out dirt, and makes possible the use of the carrier without the small boxes.

2. *Material required.*

a. *Lumber.* Tideland spruce, white pine, fir, cypress, etc.

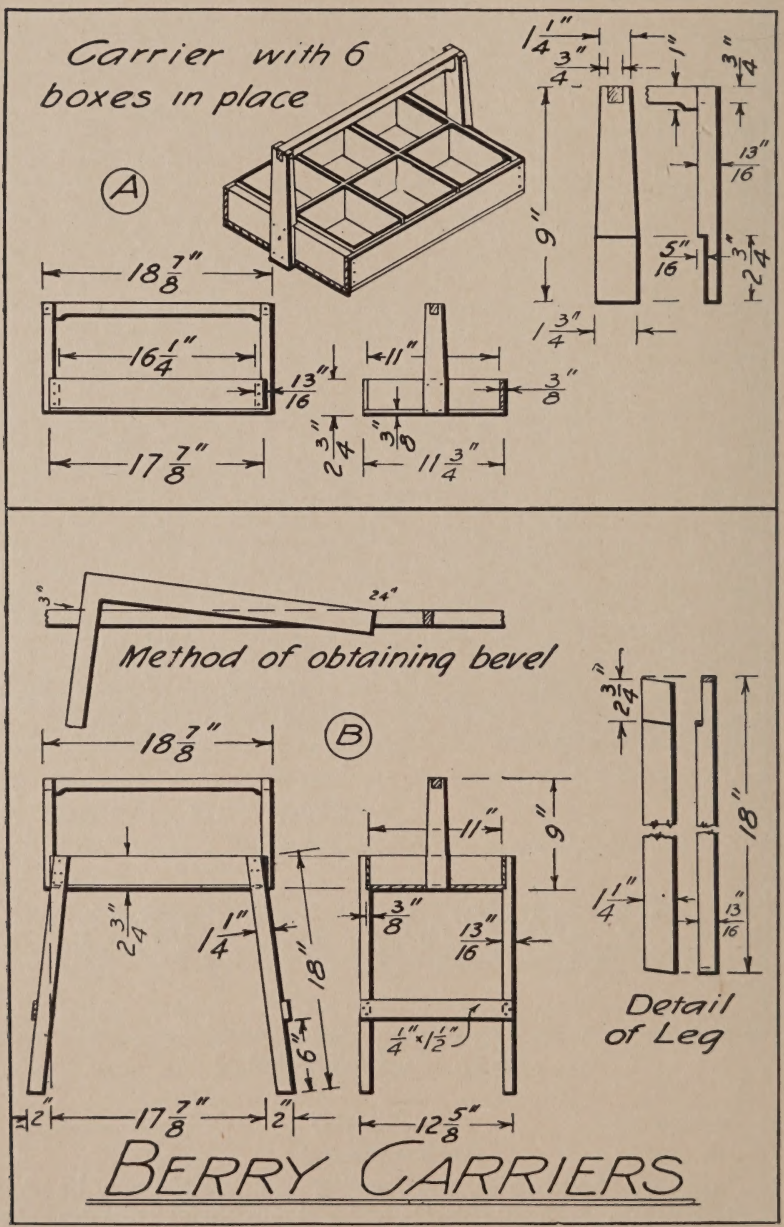


FIG. 98. BERRY CARRIERS

No. of Pieces	Dimensions	Purpose
1	$\frac{3}{8}''$ × $11\frac{3}{4}''$ × $17\frac{7}{8}''$	Bottom
2	$\frac{3}{8}''$ × $2\frac{3}{8}''$ × $17\frac{7}{8}''$	Sides
2	$1\frac{3}{16}''$ × $2\frac{3}{8}''$ × 11″	Ends
2	$1\frac{3}{16}''$ × $1\frac{3}{4}''$ × 9″	Uprights
1	$\frac{3}{4}''$ × 1″ × $18\frac{7}{8}''$	Handle

b. *Hardware.* 3 dozen 3d. wire nails.

3. *Directions.*
   a. Nail uprights to end pieces, then sides to end pieces.
   b. Fasten on the bottom, and finally nail or screw the handle in place.
   c. The carrier should be well nailed in order to hold up well under rough usage.

Berry Carrier

(For raspberries and blackberries)

1. *Purpose.* The carrier "B" is for berries that are some distance from the ground, such as raspberries and blackberries. The carrier is exactly like carrier "A" with the exception of having legs.
2. *Material required.* In addition to that specified for carrier "A" the following material is needed:

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{16}''$ × $1\frac{1}{4}''$ × 18″	Legs
2	$1\frac{3}{16}''$ × $1\frac{1}{2}''$ × $12\frac{5}{8}''$	Spreaders

Hardware. An additional 2 dozen nails, 3d. and 6d.

3. *Directions.* Fasten the spreaders to the legs before fastening the legs to the body of the carrier. The legs may be nailed on rigidly or may be fastened on with screws so as to be removable.

Strawberry Runner Cutter

1. *Purpose.* The largest and best strawberries are usually obtained when the plants are properly spaced in rows and when the runners are kept cut. The runner cutter shown in Fig. 100 is a handy home-made device that is extensively used in strawberry culture.
2. *Material required.* One piece of old cross-cut saw blade or other piece of thin steel, three iron or steel rods, about $\frac{7}{16}''$ in diameter, an old fork handle with ferrule, and a couple of soft metal, soft iron, or copper rivets.
3. *Directions.*
   a. Cut the blade to the required size, drill the holes for the three

Fig. 99. Strawberry Runner Cutter

Made by pupils under Glen W. Dietrick, Supervisor of Agriculture, the Vocational School, Lampeter, Pa.

arms and for the end rivets, and rivet the ends together after the ends have been beveled off.

b. Weld the three arms together and draw them to a square taper of a size that will fit the ferrule.

c. Rivet the arms to the blade.

d. Sharpen the cutting edge on an emery wheel or with a file.

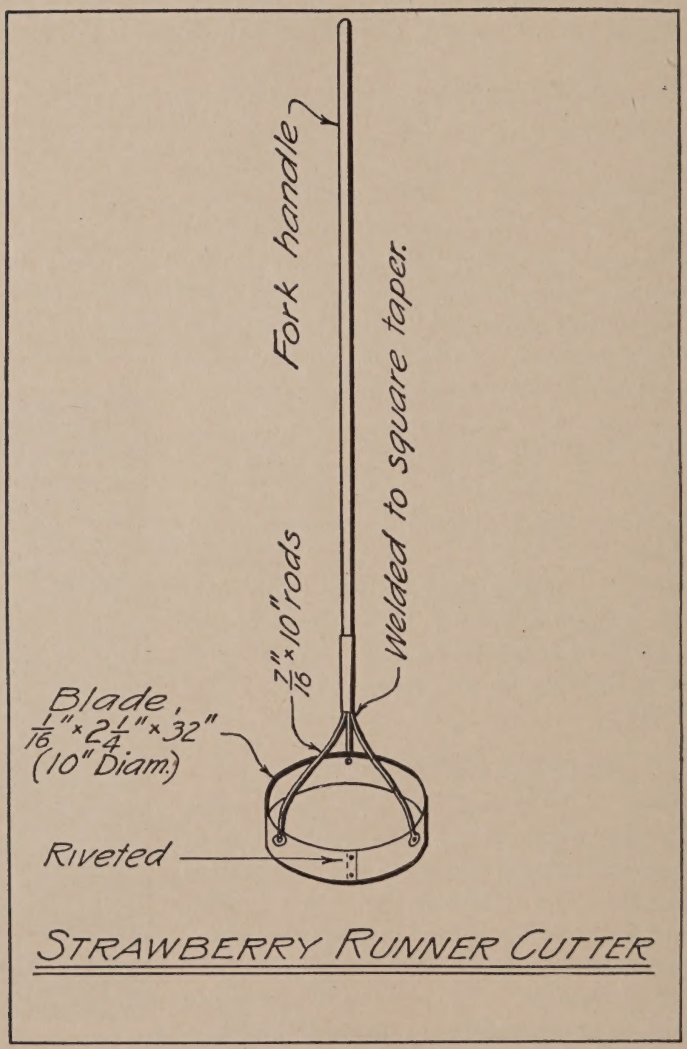


FIG. 100. STRAWBERRY RUNNER CUTTER

4. *Method of use.* The operator walks along the row of plants and drops the tool over each plant in such a way as to cut all runners from any one plant in a single operation.

Stepladder

1. *Purpose.* The stepladder shown in Fig. 102 is of simple, rigid construction, and is used to pick fruit around the lower parts of trees. It is such as women or children may use with comparative safety, and is a useful home-made device that may serve a variety of purposes.
2. *Material required.*
   a. *Lumber.* A light wood, such as white pine, cypress, cedar, or tideland spruce is to be preferred.

No. of Pieces	Dimensions	Purpose
2	$^{13}/_{16}'' \times 5^{3}/_{4}'' \times 5'$	Stringers
5	$^{13}/_{16}'' \times 4^{3}/_{4}'' \times 18''$	Treads
1	$^{13}/_{16}'' \times 5^{3}/_{4}'' \times 18''$	Top tread
2	$^{13}/_{16}'' \times 2^{3}/_{8}'' \times 4'$	Legs
2	$^{13}/_{16}'' \times 2^{3}/_{8}'' \times 2'$	Braces (horizontal)
1	$^{13}/_{16}'' \times 2^{3}/_{8}'' \times 16^{3}/_{8}''$	Brace (horizontal)
2	$^{1}/_{2}'' \times 1^{1}/_{2}'' \times 3'$	Braces (diagonal)

   b. *Hardware.*
      3 dozen 6d. common wire nails.
      1 dozen 6d. finishing nails.
3. *Directions.*
   a. Mark off one stringer with a steel framing square, using a 4 and 8 cut. Cut this out and use it for a pattern for the other one.
   b. All joints are nailed.
   c. If linseed oil or paint is used on the ladder, it will not become water-soaked and heavy during rainstorms when in the orchard.

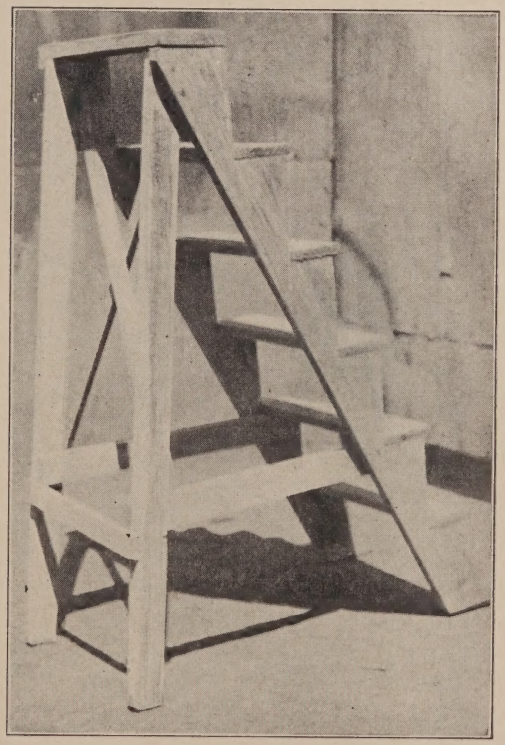


Fig. 101. Stepladder, Orchard Type

Orchard Ladder

1. *Purpose.* The orchard ladder shown in Fig. 104 is one that can readily be placed between the laden branches of fruit trees. The point is placed in the crotches of the branches of the tree.

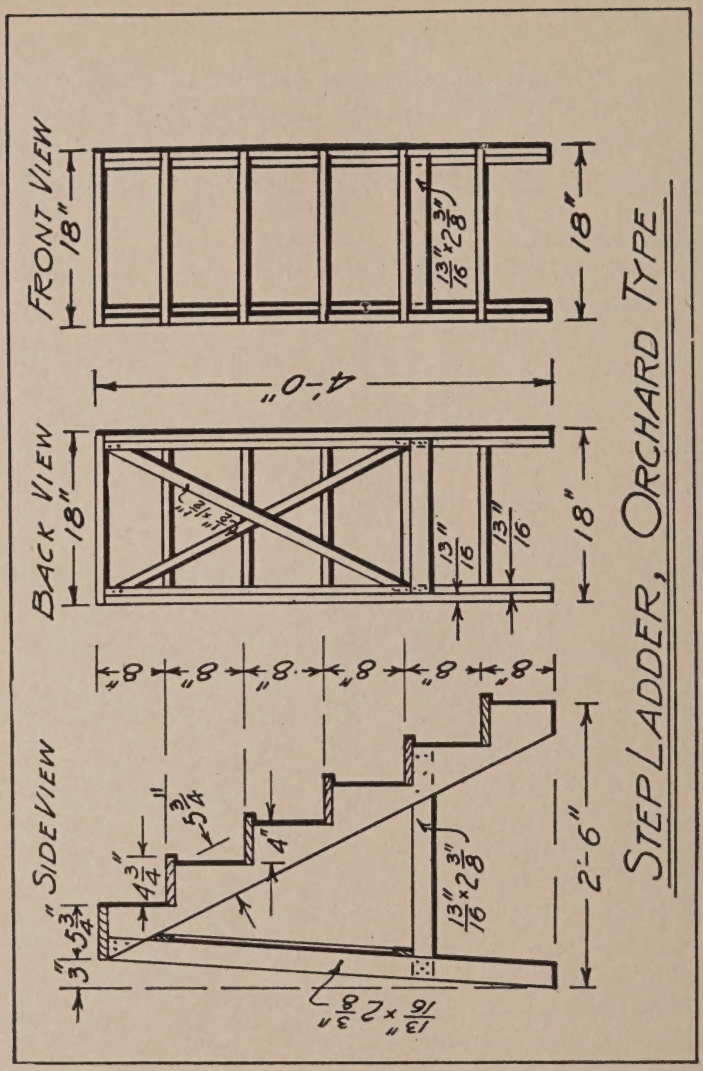


Fig. 102. Stepladder, Orchard Type

2. *Material required.*

a. *Lumber.* A light and yet strong wood such as Douglas fir, ash, or yellow pine is best.

No. of Pieces	Dimensions	Purpose
2	1¼″ × 3″ × 10′	Sides
1	1¾″ × 1¾″ × 2′ 6″	Tip
	18 lineal ft. 13/16″ × 1¾″	Rungs

b. *Hardware.*

⅓ lb. 6d. wire nails.

1 bolt ¼″ × 4″ with washers.

1 bolt ¼″ × 6″ with washers.

3. *Directions.*
   a. Lay the two side pieces on the floor with their base ends 2′ 10″ apart. Hold the tip piece in its correct position and mark the bevel for the side pieces at their top ends.
   b. Lay off the spaces for the rungs, and notch out the side pieces for the rungs. Note that the notches are not square across the edges

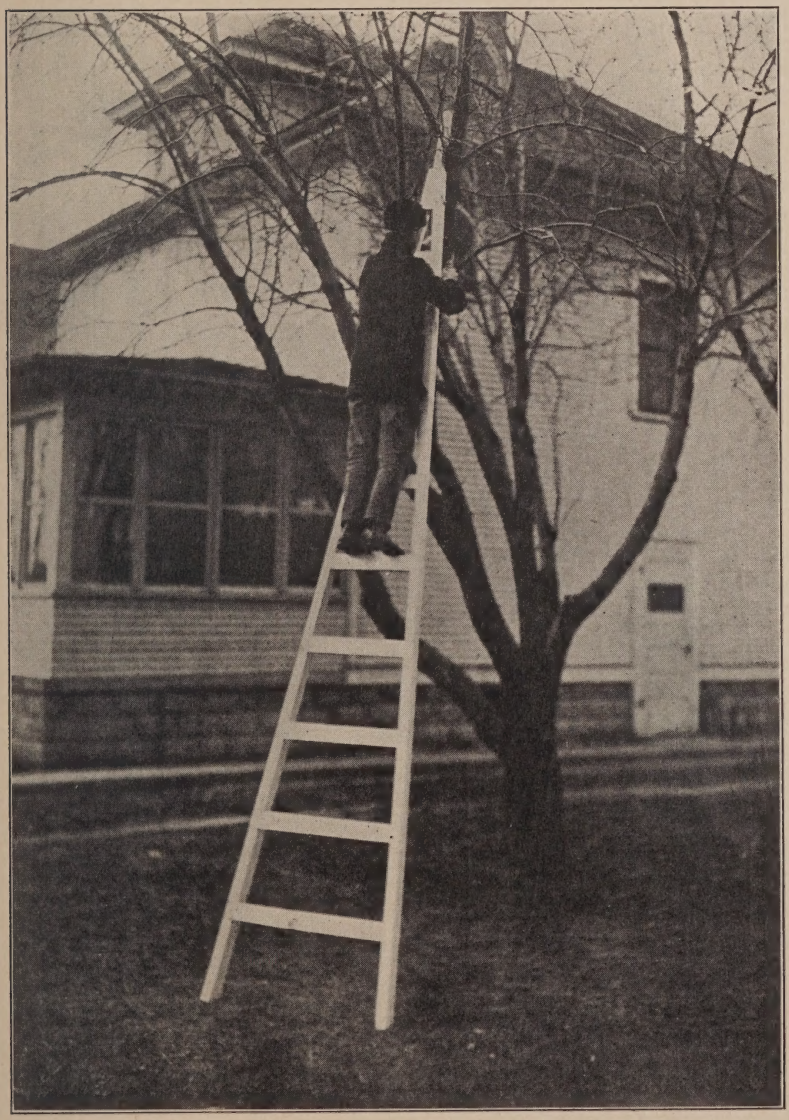


FIG. 103. ORCHARD LADDER

Made by Chas. Brooker, Fairmount, Minn. Mr. Paul Calrow, Director of Vocational Agriculture. Photograph, courtesy of Mr. B. M. Gile. State Supervisor of Agricultural Education, St. Paul.

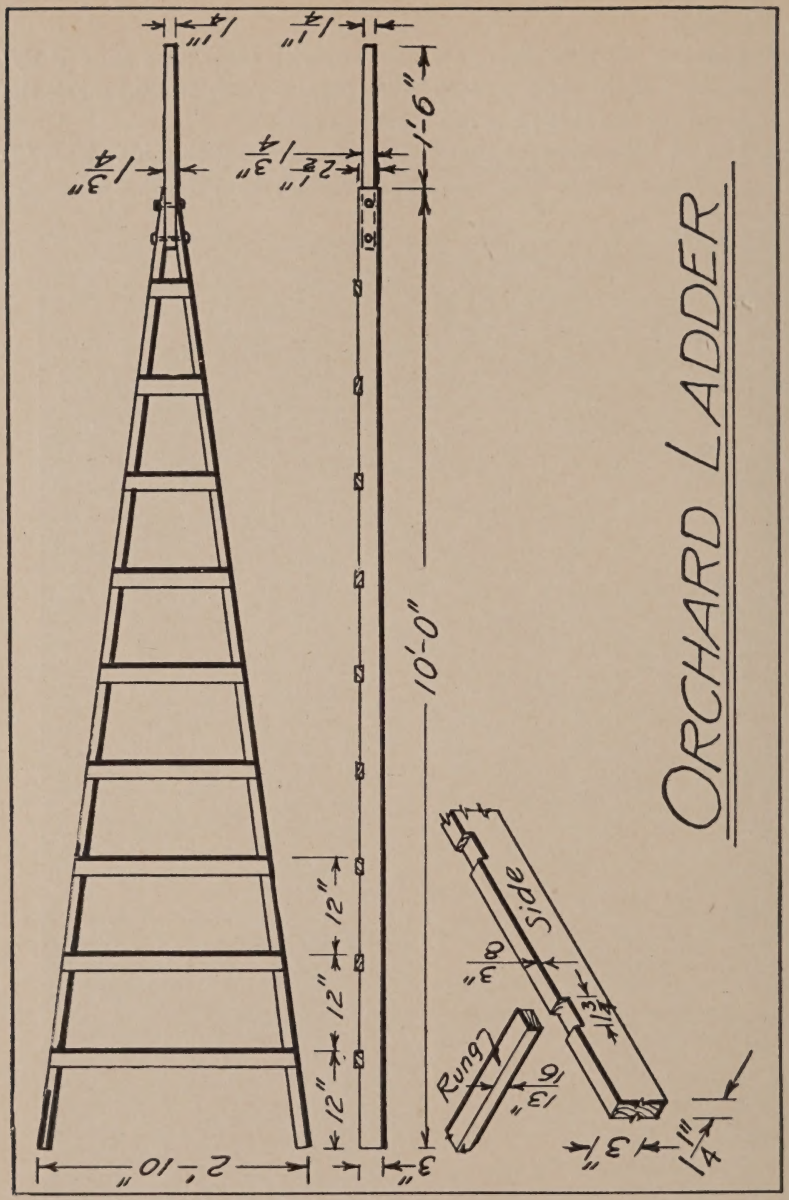


Fig. 104. Orchard Ladder

of the side pieces. Obtain this angle by scribing across the edges with a straight edge, or use a piece of the material to be used for the rungs. The angle may be duplicated by means of a bevel square or with a framing square.

c. Bolt the tip in place before fastening the rungs. The latter may be nailed or screwed on. The diameter of the nails or screws will have to be judged by the characteristics of the lumber.

d. Finish with linseed oil, or paint.

Orchard Ladder

1. *Purpose.* Another type of orchard ladder that combines many desirable characteristics is shown in Fig. 105. A ladder having but one leg on the swinging portion can be placed in positions where certain other ladders cannot be placed.
2. *Material required.*
   a. *Lumber.* Should be of the best quality, light and strong; as, for example, Douglas fir, ash, or yellow pine.

No. of Pieces	Dimensions	Purpose
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 10'\ 6''$	Legs (rigid)
1	$1\frac{3}{4}'' \times 1\frac{3}{4}'' \times 10'\ 6''$	Leg (swinging)
	15 lineal ft. $1\frac{3}{16}'' \times 3\frac{3}{4}''$	Steps
1	$1\frac{3}{16}'' \times 7\frac{3}{4}'' \times 14\frac{5}{8}''$	Top step
1	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 14\frac{1}{2}''$ (oak)	Top to swinging leg
	20 lineal ft. $\frac{1}{2}'' \times 1\frac{1}{2}''$	Braces

   b. *Hardware.*
      2 carriage bolts $\frac{1}{4}'' \times 4\frac{1}{2}''$ with washers.
      4 lineal ft. light chain with hook and 2 screw eyes.
      4 doz. 8d. common wire nails or same number of $1\frac{1}{2}''$ No. 8 or 9 flat head bright screws.
      2 doz. 3d. common wire nails.
      1 doz. $1\frac{1}{4}''$ No. 8 flat head bright screws.
3. *Directions.*
   a. Find the exact length and cut the proper bevels on the rigid legs by using the framing square as shown at "E." This also gives the bevels for the dado cuts in the rigid legs.
   b. In marking off the rigid legs, one may be marked off with a square, and the other then brought alongside so that the marks can be scribed across, either with a bevel square or with a framing square.
   c. The true lengths of all steps except the top one may be obtained by the method shown at "F." The pieces are first cut at lengths a little longer than needed, or short ends are utilized. They are then placed side by side. A distance equal to the length of the smallest step is laid off on one end piece equidistant from a center line, and a distance equal to that of the longest step is laid off on the piece farthest from the first in the same manner. A straight edge (a piece of straight lumber) is used to connect the points as shown. Each piece is then squared at its ends, and is cut true to length. Another method is to calculate the lengths of the steps. This is apt to lead to errors.
   d. The cross-piece "B" should be fastened securely to the swinging leg, and must be placed in its final position before the top steps of the ladder with its reënforcing brackets is put in place. The

brackets are fastened before the top step is nailed or screwed down.

e. The ladder should be given several coats of boiled linseed oil, or good exterior paint.

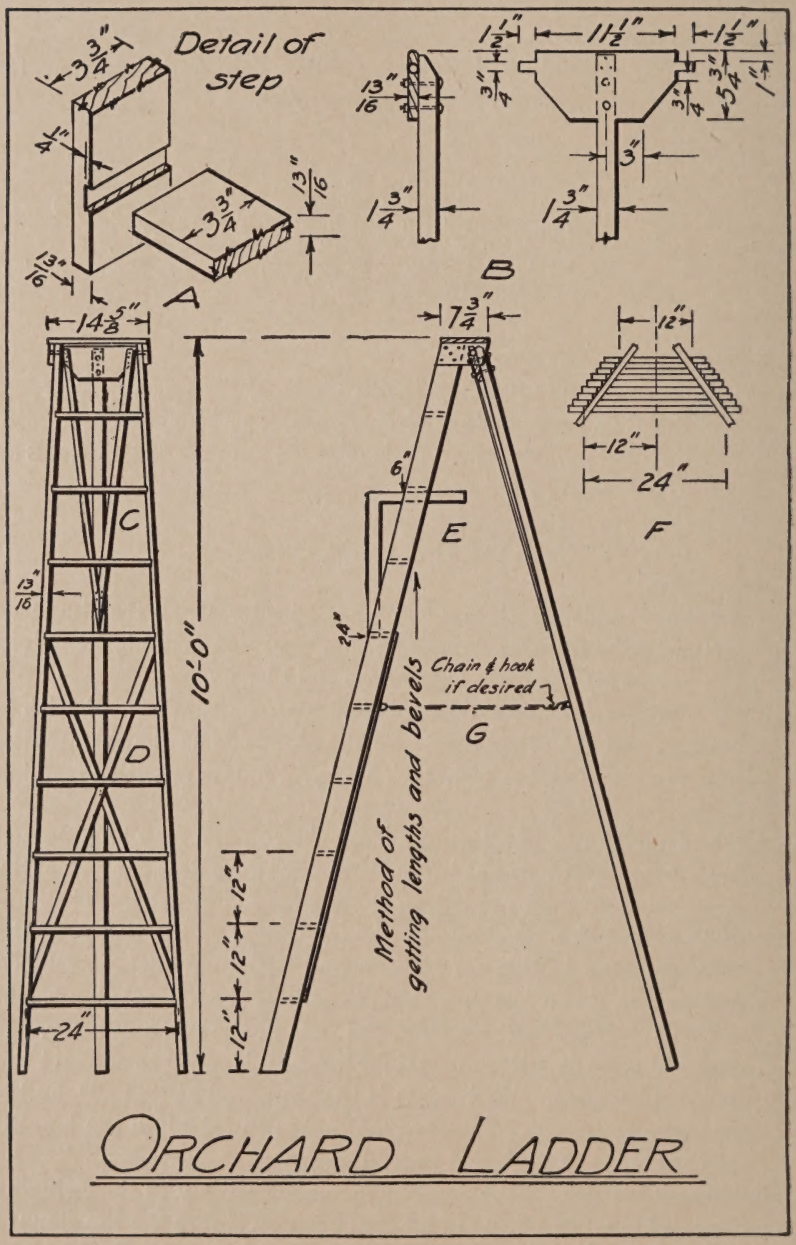


FIG. 105. ORCHARD LADDER

Prop for Fruit Trees

1. *Purpose.* Heavily laden fruit trees frequently need to have their branches supported in order to avoid their breaking. Several methods are employed. One is to drive screw eyes into branches on opposite sides of the tree, and connect these screw eyes (or eye-bolts if the branches are large) with heavy wire in such a way that one branch counterbalances the other. A second method is to use saplings having crotches at the ends. A third method is to use a prop made of sawed lumber, with a burlap or rag cushion to prevent injury to the limb.

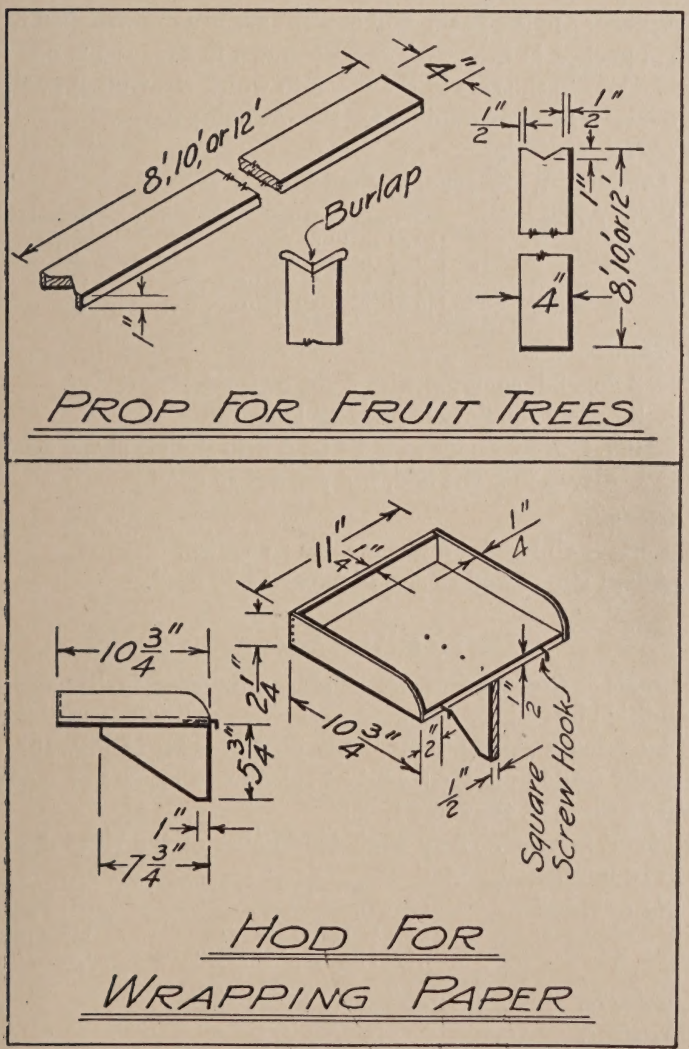


FIG. 106. PROP FOR FRUIT TREES AND HOD FOR WRAPPING PAPER

2. *Material required.* Any available kind of lumber may be used. Smooth lumber free from bark is to be preferred.
3. *Directions.* The props should usually vary in length. Fold burlap or rags into a smooth cushion and fasten with a shingle nail. Drive the nail well in.

   At the end of the season and in the early summer dip the burlap-covered ends into boiling hot water or into standard arsenate of lead spray to kill any codling moth or other insects that may be harbored there. Store props in neat piles when not in use.

Hod for Wrapping Paper

1. *Purpose.* Apples, pears, and oranges are usually wrapped in paper when packed in boxes. The hod shown in Fig. 106 is one that is hooked on to the side of the box into which the fruit is packed and provides a handy container for the wrapping paper.
2. *Material required.*

   a. *Lumber.* White pine, or similar wood.

No. of Pieces	Dimensions	Purpose
1	½″ × 10½″ × 10½″	Bottom
2	¼″ × 2¼″ × 10¾″	Sides
1	¼″ × 2¼″ × 10½″	Back
1	½″ × 5¾″ × 7¾″	Bracket

   b. *Hardware.*

   3 doz. 3d. common wire nails, or brads.

   2 square shoulder hooks 1½″ long.

   (6d. finishing nails may be bent into similar shape after being driven into the hod, but are not so good.)
3. *Directions.*

   a. Surface all lumber and assemble as shown.

   b. Adapt size of hod to size of paper to be used.

Jig for making Apple Boxes

1. *Purpose.* Apple boxes are usually purchased in "knock-down" condition by fruit-growers. An easy way of "nailing up" the boxes is by using a simple home-made jig as shown in Fig. 107. This may be made in any convenient length so that one or more boxes can be made at the same time.
2. *Material required.* Any available lumber of the right dimensions can be used.

No. of Pieces	Dimensions	Purpose
1	1¾″ × 11¾″ × 4′	Main support
4	13/16″ × 13/16″ × 10½″	Cleats

   Hardware. Sixteen 4d. common wire nails.
3. *Directions.*

   a. Draw lines square to the edge of the plank with a framing square

where the cleats are to be nailed. The spacing of the cleats depends on the size of the boxes to be made.

b. The space between each pair of cleats should be such that the end boards of the box to be made will fit in snugly without binding.

c. The cleats should be slightly shorter than the width of the end boards of the boxes to be nailed. This permits the box to rest directly on the plank when the bottom boards are nailed on.

d. A place for the box nails to be used can be made by fastening a small cigar box or similar object to the plank at the left end.

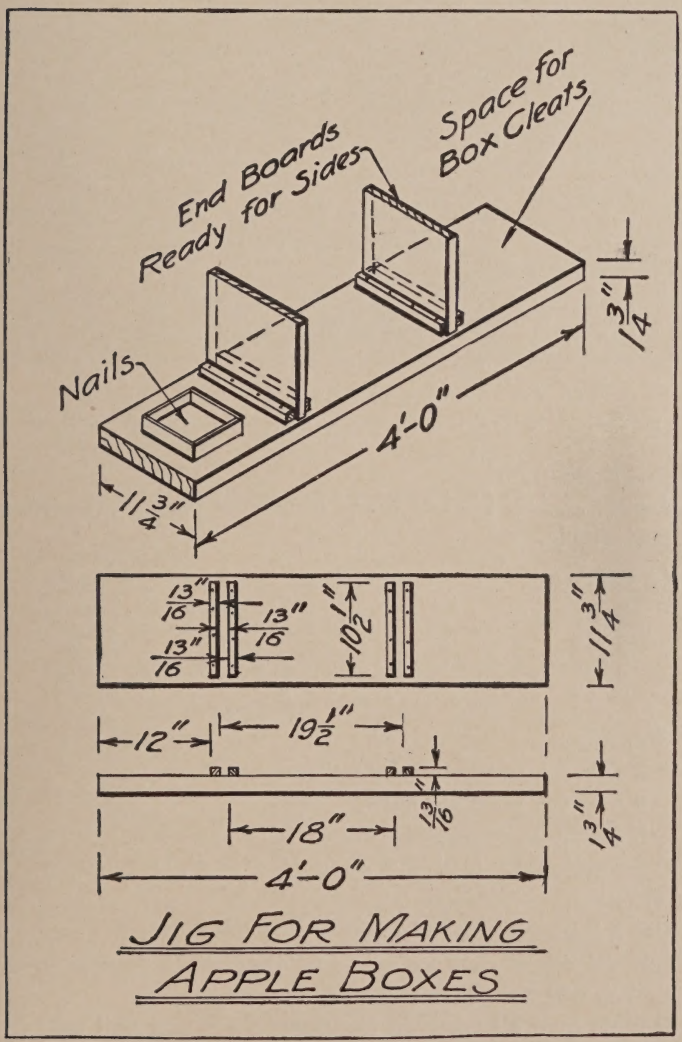


FIG. 107. JIG FOR MAKING APPLE BOXES

e. The jig may be supported on a pair of horses, or by some empty boxes. The support should be as rigid as possible.

Packing Table

1. *Purpose.* Packing tables are used as a means of distributing fruit within easy reach of the packer. Tables similar to the one shown in Fig. 109 are used extensively.

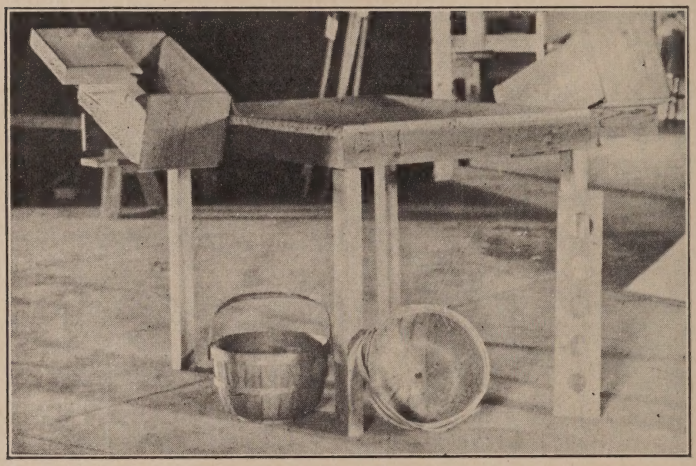


FIG. 108. PACKING TABLE FOR APPLES AND PEARS
Built and used by the Pennsylvania State College, Department of Horticulture.

2. *Material required.*
   a. *Lumber.* Any kind of sound lumber of proper proportions that is available.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 3'$	Legs
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 5'\ 6''$	Sides
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 3'\ 4\frac{3}{8}''$	Ends
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 5'\ 6''$	Bottom
8	$1\frac{3}{16}'' \times 1\frac{3}{4}'' \times 2'$	Braces

   b. *Hardware.*
      3 doz. 6d. common wire nails.
      3 doz. 6d. finishing nails.
      ¼ lb. 3d. common wire nails.
   c. *Other material.* 1 piece 8 oz. duck 4′ × 5′.
3. *Directions.*
   a. Use a framing square in assembling the table.
   b. Cut the top of each leg off at an angle of 45 degrees so that the canvas will not touch them as it sags.
   c. Double over all edges of the duck cover and nail well with 3d. common wire nails.

d. If old garden hose is available, it may be split lengthwise, and the half-sections can be nailed along the edges of the table. This helps to keep the apples from rolling off the table, and protects them from being injured on the edges of the table.

e. The table is readily cleaned by sweeping it, or by tilting it slightly and beating the duck cover.

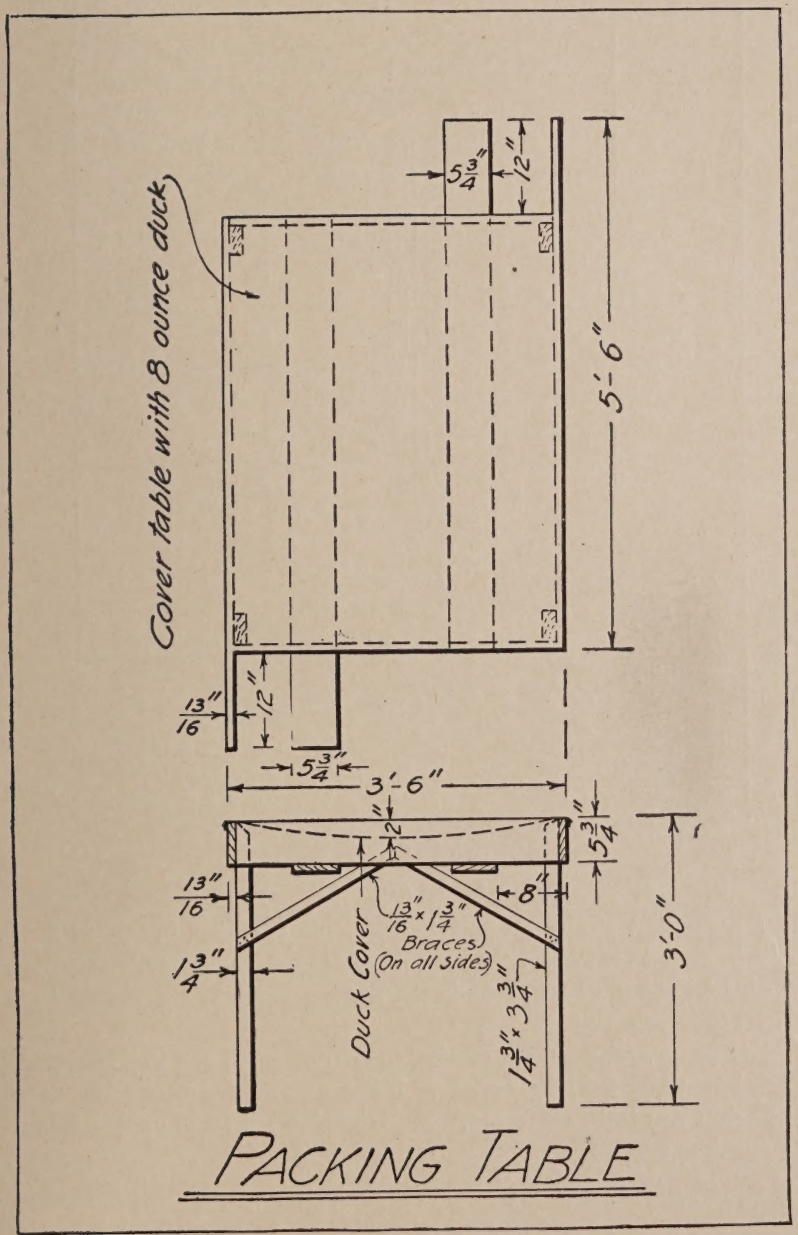


Fig. 109. Packing Table

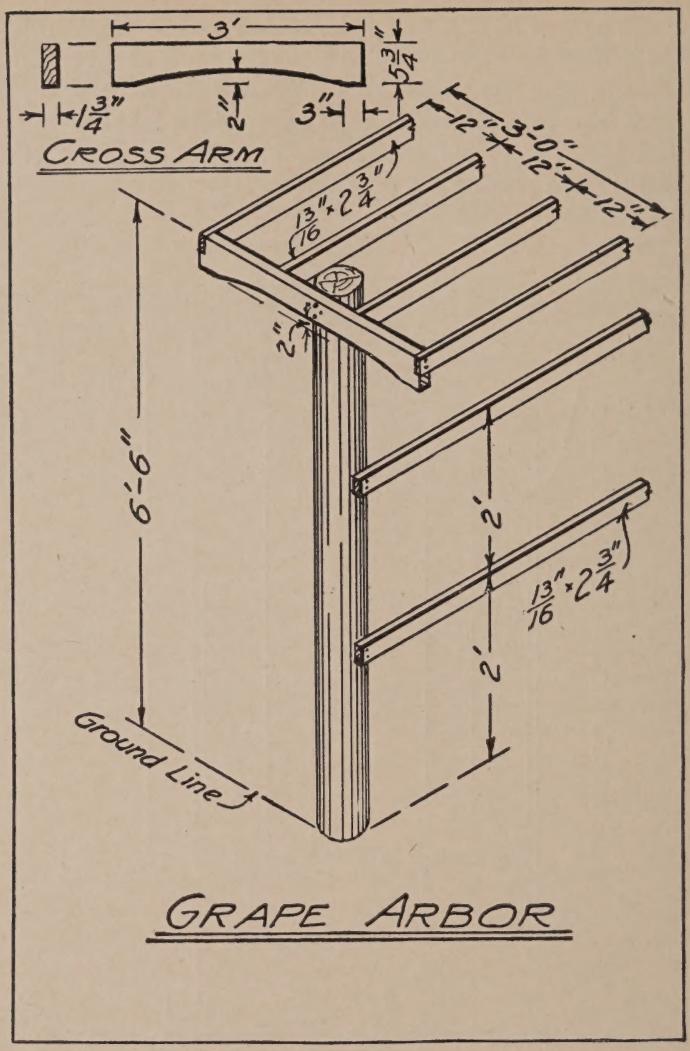


FIG. 110. GRAPE ARBOR

Grape Arbor ("T" Shape)

1. *Purpose.* A simple grape arbor or trellis is shown in Fig. 110. It is intended for grapes that are planted in a single row. The posts ought to be 6′ to 10′ apart in the row.
2. *Material required.*
   a. *Lumber.* The kind of lumber to be used will have to be governed largely by the local supply. Posts, and lumber that resist decay well, are to be preferred. For a section ten feet long the following is needed:

No. of Pieces	Dimensions	Purpose
2	6″ × 6″ × 8′ 6″	Posts
2	1¾″ × 5¾″ × 3′	Cross arms
6	13/16″ × 2¾″ × 10′	Supports

b. *Hardware.*

2 dozen 8d. common wire nails.

8 20d. common wire nails.

c. *Paint.* Several coats of paint will add to the attractiveness and life of the woodwork.

3. *Directions.*

a. Set the posts 2′ into the ground, nail on the cross arms, and saw off the top of the post at the right distance from the ground. If care is taken to dig the hole exactly the right depth, it will not be necessary to saw the post for length after it is up.

b. The trellis work should be nailed to the cross arms edgewise as shown, as they will not sag so much that way.

c. It will be well to place "spacers" between the four top trellis bars at distances of three or four feet. Use $1\frac{3}{16}'' \times 2\frac{3}{4}'' \times 11\frac{3}{16}''$ material.

Grape Arbor

1. *Purpose.* Grape arbors serve a useful as well as ornamental purpose. The one shown herewith is simple and substantial. The main branches may be tied or wired to the arbor. Posts are set about 6 feet apart between rows, and 6 to 8 feet within the rows.

2. *Material required.*

FIG. 111. GRAPE ARBOR
Built at Avondale, Pa.

a. *Lumber.* Any variety that resists decay well; as, for example, cedar, chestnut, cypress, etc. For a section twelve feet long the following is required:

No. of Pieces	Dimensions	Purpose
6	6″ × 6″ × 9′	Posts
3	13/16″ × 11½″ × 6′	Cross ties
8	13/16″ × 2¾″ × 14′	Lattice work
2	13/16″ × 5¾″ × 14′	Side boards
1	1¾″ × 3¾″ × 14′	Ridge board

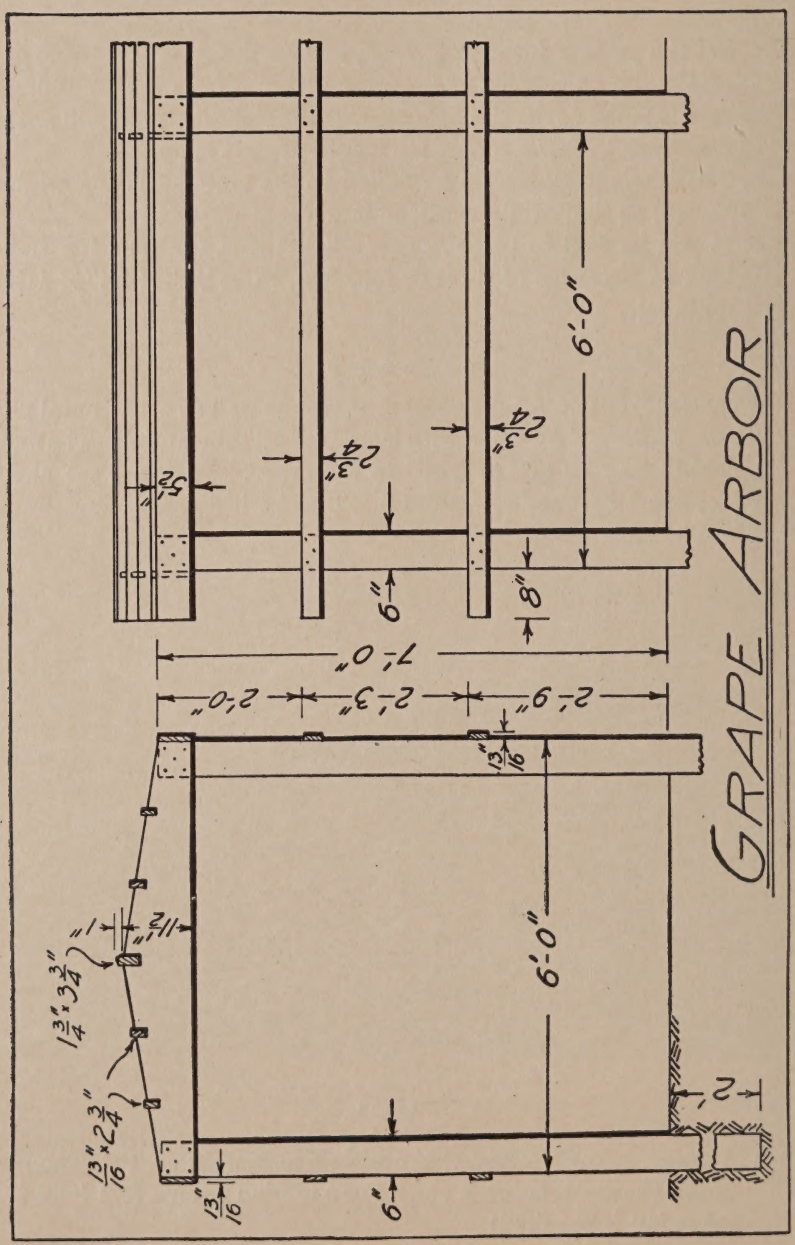


Fig. 112. Grape Arbor

b. *Hardware.*

1 lb. 8d. common wire nails.

¼ lb. 8d. finishing nails.

3. *Directions.* The directions given for constructing the "T"-shaped arbor apply also to this one. Use a spirit plumb, or a plumb bob in setting the posts. Round or tapered posts are plumbed from their center lines.

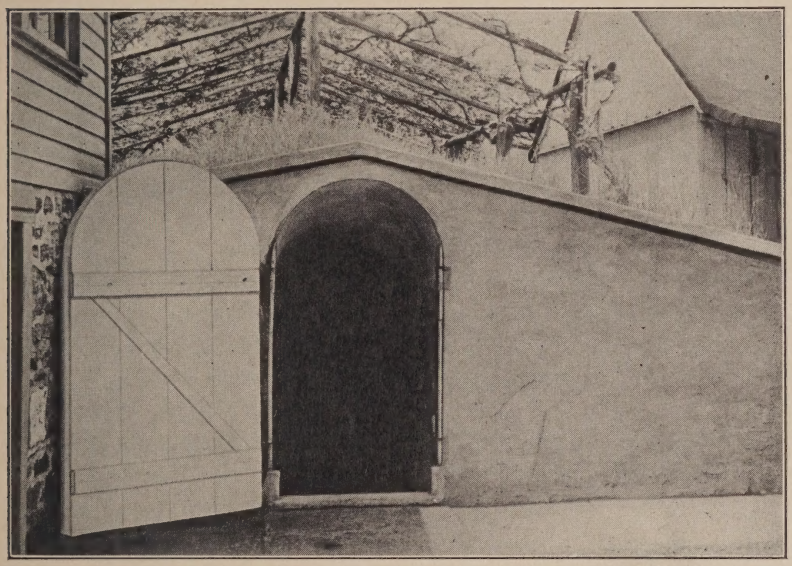


FIG. 113. RUSTIC GRAPE ARBOR OVER A STORAGE CELLAR OWNED BY THE PENNSYLVANIA STATE COLLEGE

The arbor helps to maintain uniform temperature in the cellar.

REFERENCES

1. *Free bulletins and circulars.*

Culture of Currants and Gooseberries. Loree, R. E. Circular No. 38, 1919. Experiment Station, Michigan Agricultural College, East Lansing.

Growing Fruit. Gould, H. P., and Darrow, George M. Farmers' Bulletin 1001.

Managing the Orchard. Moore, J. G. Bulletin 269, 1916. Agricultural Experiment Station, Madison, Wis.

Packing of Apples in California, The. Tufts, Warren P. Circular 178, 1917. Agricultural Experiment Station, Berkeley, Cal.

Planting of Orchards, The. Extension Circular 15. School of Agriculture, State College, Pa.

Press for the Gorgia Carrier, A. Blake, M. A., and Haines, Harry C. Circular 64, 1917. Agricultural Experiment Station, New Brunswick, N.J.

Packing of Apples in Barrels and Boxes, The. Wolff, W. H. Extension Circular No. 7, 1916. New Hampshire College of Agriculture, Durham.

Planting that Nursery Stock. Moore, J. G., and Anst, F. A. Extension Circular 111, 1919. College of Agriculture, University of Wisconsin, Madison.

Raspberry Culture. Loree, R. E. Circular No. 37, 1919. Agricultural Experiment Station, East Lansing, Mich.

Suggestions on Planting Orchards. White, O. K. Reprint of Bulletin 262, 1919. Agricultural Station, East Lansing, Mich.

2. *Text or reference books.*

Bailey, L. H. *Principles of Fruit Growing.* Macmillan Co.
Bailey, L. H. *The Nursery Manual.* Macmillan Co.
Bailey, L. H. *The Pruning Manual.* Macmillan Co.
Green, S. B. *Popular Fruit Growing.* Webb.
Sears, Fred C. *Productive Orcharding.* J. B. Lippincott Co.

CHAPTER IX

RELATING TO SWINE HUSBANDRY

It is usually worth while to keep a limited number of hogs on the farm. Prices of pork rise and fall; money is made and lost in producing it, depending upon several variable factors, but the hog still retains his nickname, "the mortgage lifter." This is due in part to the fact that he is a user of by-products, such as small potatoes, skim milk, buttermilk, whey, and kitchen refuse.

In order to make the production of market hogs or of pure-bred stock a profitable business enterprise, it is desirable to take advantage of labor-saving devices, and conveniences such as are presented in this chapter.

Hog Trough and Chute

1. *Purpose.* The trough and chute illustrated in Fig. 115 are designed so that kitchen refuse and other by-products can be fed to the pigs or hogs from the "opposite" side of the fence. In this way there is no inconvenience from hungry hogs trying to get close to the source of their supply of food.

   The trough may be varied in length to suit the number of hogs. A trough 3′ long is large enough for one hog. Add at least one additional foot for each hog above that number.

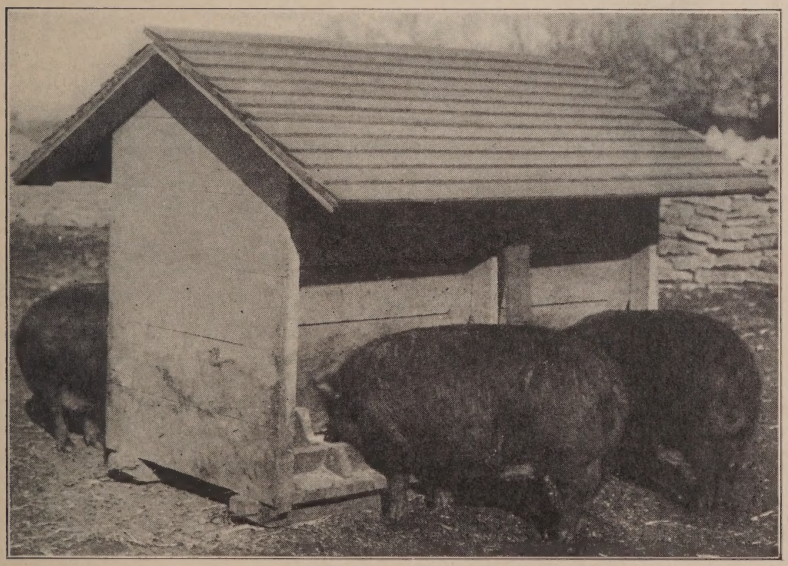


Fig. 114. The Kansas Type of Self-Feeder

Photograph, courtesy of Professor C. W. McCampell, Department of Animal Husbandry, Kansas State Agricultural College, Manhattan, Kansas.

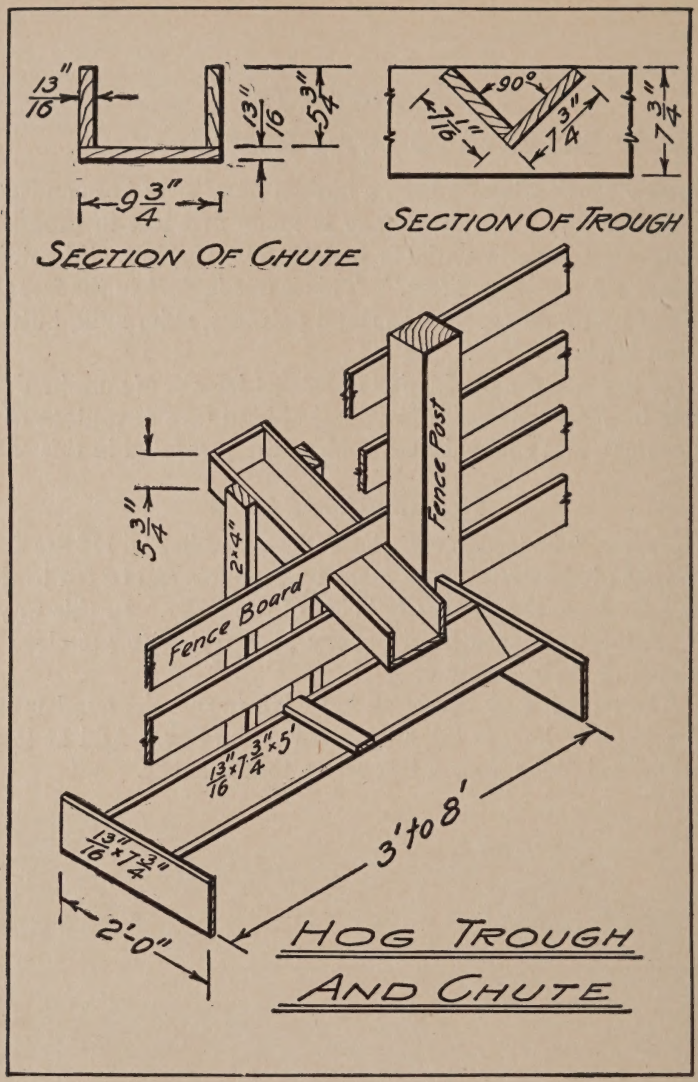


FIG. 115. HOG TROUGH AND CHUTE

2. *Material required.*

a. *Lumber.* Yellow pine, cypress, cedar, chestnut, etc. Use 1¾6" boards for 3′ lengths, 1⅛" boards for 6′ lengths, and 1¾" material for longer lengths.

The following material is required for a 3′ trough:

No. of Pieces	Dimensions	Purpose
1	1¾6" × 7¾" × 3′	Side
1	1¾6" × 6 15/16" × 3′	Side
2	1¾6" × 7¾" × 2′	Ends
1	1¾6" × 3¾" × 10"	Cross-tie

b. *Hardware.* 2 doz. 8d. common wire nails.

For a chute 3′ long the following is required:

No. of Pieces	Dimensions	Purpose
1	13/16″ × 9¾″ × 3′	Bottom
2	13/16″ × 5¾″ × 3′	Sides
1	13/16″ × 4 15/16″ × 8⅛″	End
2	2″ × 4″ × 4′	Posts

Hardware. About 2 doz. 8d. common wire nails.

3. *Directions.*
   a. Joint the edges of the boards that are to be used for the trough and for the chute.
   b. Nail the joints every 4″ to 6″.
   c. The long end boards are necessary in order to keep the hogs from turning the trough over. Set the nails about 2″ apart that go through the end pieces into the sides of the trough.

Concrete Hog Trough

1. *Purpose.* The hog trough shown in Fig. 116 is one that is permanent, and more sanitary than a wooden trough. It has the disadvantage of being heavy, and in this respect harder to clean than a wooden trough, but is well suited for a feeding floor or a hog house.
2. *Material required.*
   a. *For the form.*

No. of Pieces	Dimensions	Purpose
2	13/16″ × 11¾″ × 3′ 6″	Bottom
2	13/16″ × 9¾″ × 3′ 6″	Sides
2	13/16″ × 9¾″ × 14″	Ends
3	13/16″ × 3¾″ × 2′	Bottom cleats
4	13/16″ × 1¾″ × 9¾″	Upright cleats
2	13/16″ × 1¾″ × 3′ 6″	Cleats

   b. *For the core* (or inner form).

No. of Pieces	Dimensions	Purpose
1	13/16″ × 5¾″ × 3′	Top
2	13/16″ × 5¾″ × 3′	Sides
2	13/16″ × 1¾″ × 3′	Cleats

   c. *Concrete.* Use a 1: 2: 3 mixture.
      1 cu. ft. of Portland cement.
      2 cu. ft. of clean sand.
      3 cu. ft. of pebbles or crushed stone.
      The above amount of material will produce 3.9 cu. ft. of concrete, which is ample for this trough.
   d. *Other materials.*
      About 1 lb. 8d. common wire nails.
      5 steel or heavy wire rods ⅛″ to ¼″ × 3′ 4″.
3. *Directions.*
   a. Place the core "A" into the form "B" as shown in Fig. 116.
   b. Grease the forms, where they come in contact with concrete, with

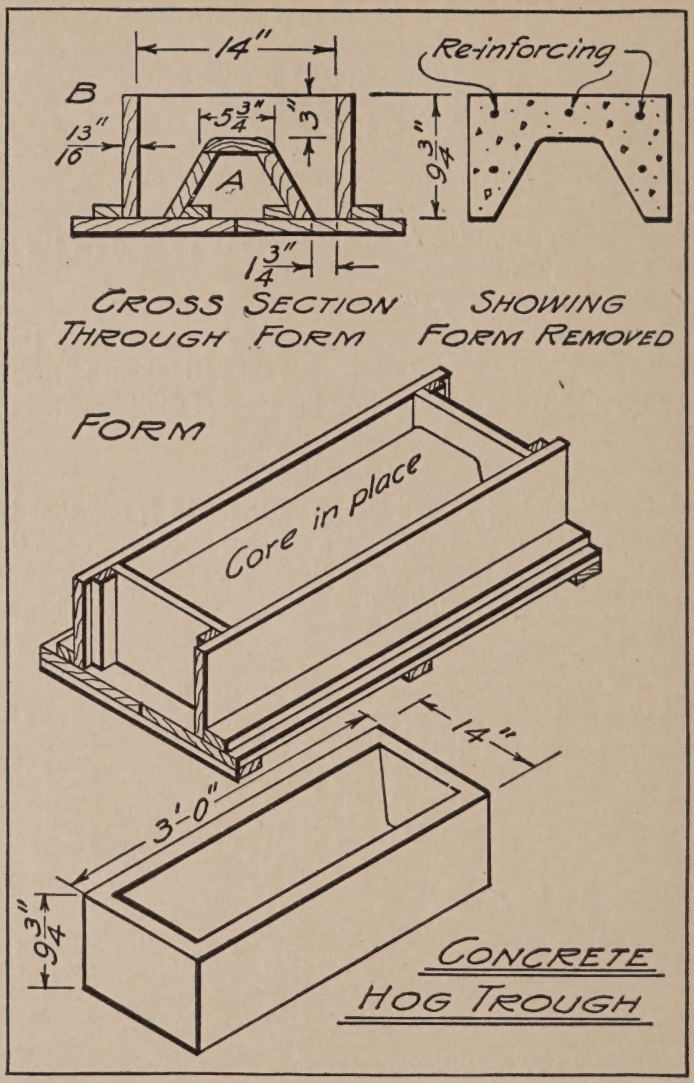


FIG. 116. CONCRETE HOG TROUGH

axle grease so that they will not stick to the concrete. The forms should be smooth.

c. Place the reënforcing in the forms. Bend ends of rods.

d. Mix the concrete and pour it in accordance with suggestions made elsewhere. (See Index.)

e. Imperfections may be touched up with a trowel and a mixture of one part of cement to one of sand.

Hog Hurdle

1. *Purpose.* Hurdles are used in animal husbandry for several purposes. Some of them are made to restrict animals to certain feeding

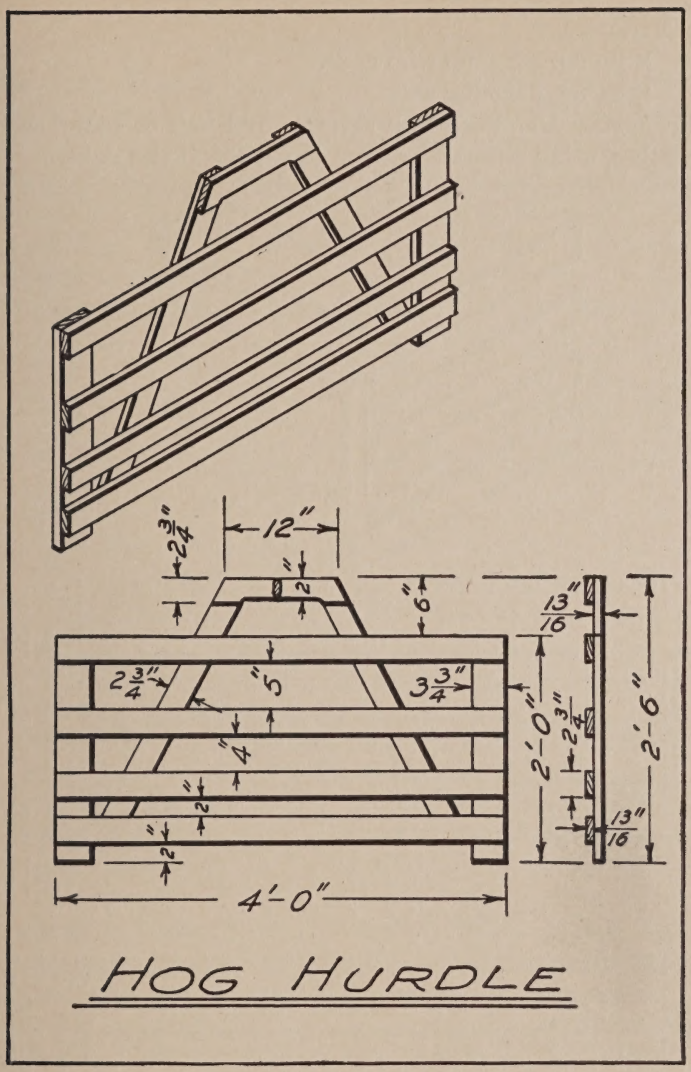


FIG. 117. HOG HURDLE

areas. The one shown herewith is used to guide hogs or to lead them where wanted. By placing the hurdle before the hog, he turns and goes lengthwise of the hurdle. It may also be used as a protection against a ferocious hog. The hurdle is managed with one hand.

2. *Material required.*

a. *Lumber.* Light lumber is best for the purpose. If ½″ material is available, it may be preferred.

NO. OF PIECES	DIMENSIONS	PURPOSE
4	$1\frac{3}{16}'' \times 2\frac{3}{4}'' \times 4'$	Rails
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 2'$	Uprights
2	$1\frac{3}{16}'' \times 2\frac{3}{4}'' \times 2'\,8''$	Diagonals
1	$1\frac{3}{16}'' \times 2\frac{3}{4}'' \times 15''$	Handle

b. *Hardware.*

¼ lb. 6d. common wire nails.

⅛ lb. 6d. finishing nails.

3. *Directions.* Hand-dress all surfaces and nail or screw the parts together, using a framing square to get the angles right.

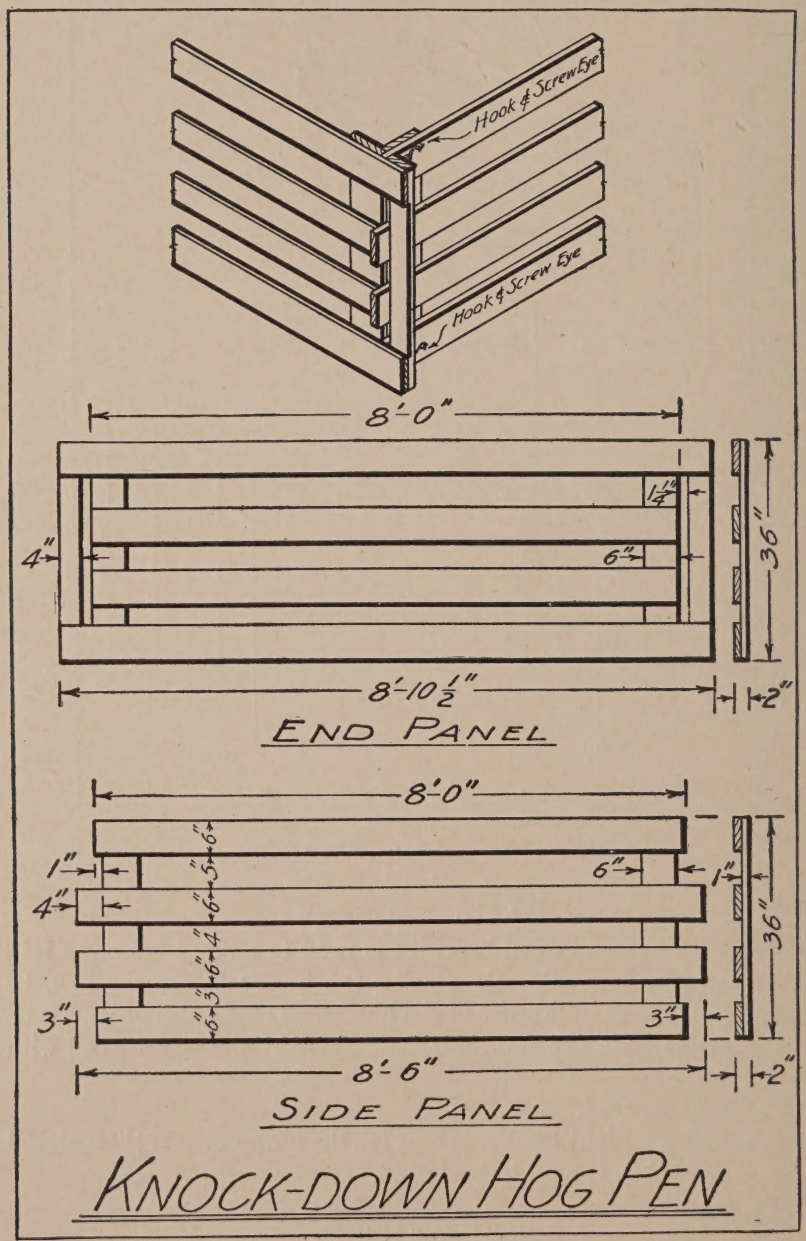


FIG. 118. KNOCK-DOWN HOG PEN

Knock-Down Hog Pen

1. *Purpose.* Various uses are found for knock-down pens. They can be used, for example, in connection with portable hog houses, and for exhibition pens. Their use is not restricted to hogs. The one shown herewith is fastened with hooks and screw eyes.
2. *Material required for one side panel and one end panel.*
   a. *Lumber.* Durable but relatively low-priced lumber should be used.

No. of Pieces	Dimensions	Purpose
2	1″ × 6″ × 8′ 6″	Rails, side panel
2	1″ × 6″ × 8′	Rails, side panel
2	1″ × 6″ × 3′	Uprights, side panel
2	1″ × 6″ × 8′ 10½″	Rails, end panel
2	1″ × 6″ × 8′	Rails, end panel
2	1″ × 6″ × 3′	Uprights, end panel
2	1″ × 4″ × 3′	Uprights, end panel

   b. *Hardware.*
      1 lb. 8d. common wire nails.
      2 galvanized or wrought iron hooks and screw eyes or hooks and staples.
3. *Directions.*
   a. Note that the above list of material is for only one side and one end.
   b. Fasten the parts together with 8d. nails, clinching them well with the grain of the lumber rather than crosswise of it.
   c. Vary the spacings between rails and the lengths of the panels to suit.

Shipping Crate for Hogs

1. *Purpose.* Persons raising pure-bred breeding stock frequently need to crate live hogs for shipment. The drawing shown herewith shows dimensions for crates of various sizes.
2. *Material required for Size No. 3.*
   a. *Lumber.* Yellow pine, hemlock, spruce, etc.

No. of Pieces	Dimensions	Purpose
9	13/16″ × 5½″ × 19⅝″	Bottom
4	13/16″ × 3½″ × 2′ 6″	Uprights
2	13/16″ × 5½″ × 4′	Sides
6	13/16″ × 3½″ × 4′	Sides
2	13/16″ × 5½″ × 19⅝″	Ends
2	13/16″ × 3½″ × 19⅝″	Ends
2	13/16″ × 3½″ × 19⅝″	Top
4	13/16″ × 3½″ × 18″	Top
1	1″ × 1″ × 16″	Cleat
2	13/16″ × 7¾″ × 2′ 6″	Ends
1	¾″ round × 3″ long	Plug

   b. *Hardware.*
      1 lb. 8d. common wire nails.
      ½ lb. 6d. common wire nails.

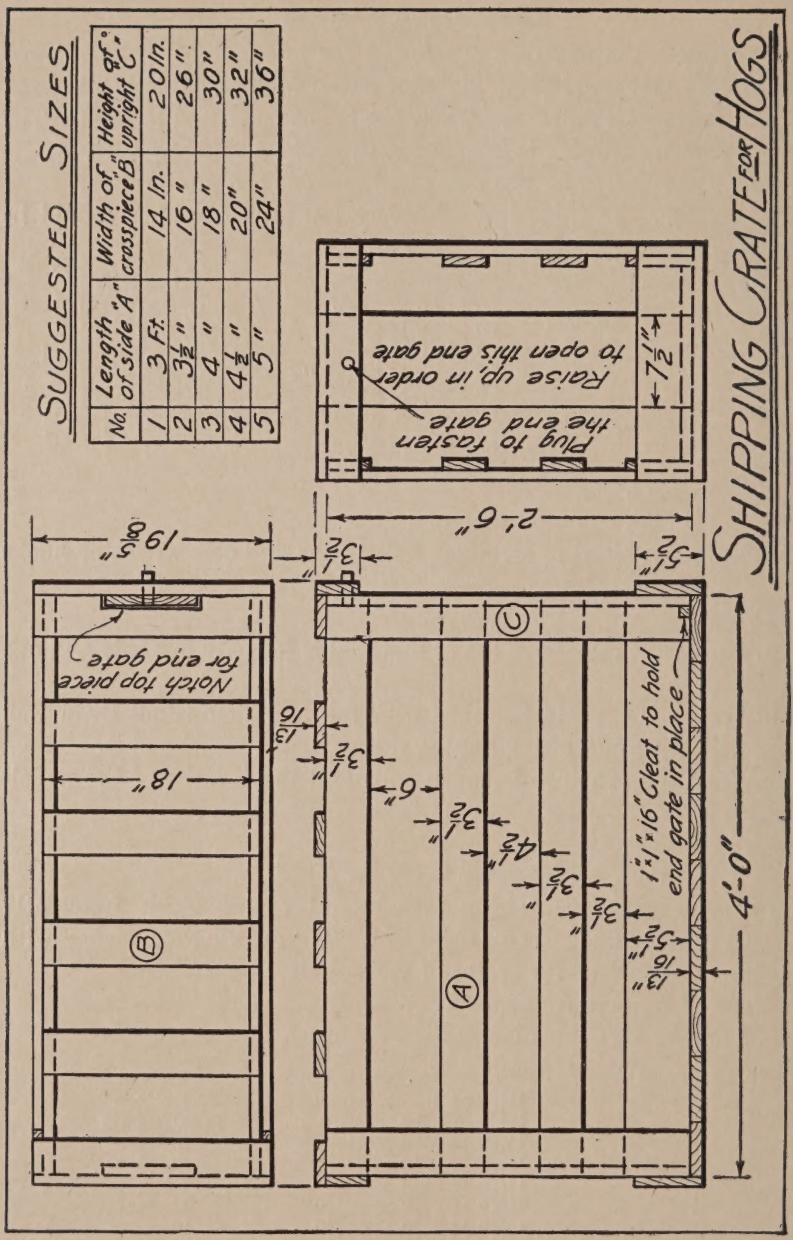

SHIPPING CRATE FOR HOGS
SUGGESTED SIZES
No. | Length of side "A" | Width of "B" crosspiece | Height of upright
1 | 3 Ft. | 14 In. | 20 In.
2 | 3½" | 16" | 26"
3 | 4" | 18" | 30"
4 | 4½" | 20" | 32"
5 | 5" | 24" | 36"
Plug to fasten the end gate
Raise up in order to open this end gate
7½"
2'-6"
19⅝"
Notch top piece for end gate
18"
16"
6"
4'-0"
1"x1"x16" Cleat to hold end gate in place
A
B
C

Fig. 119. Shipping Crate for Hogs

3. *Directions.*

a. In nailing up the crate, fasten all parts securely with 8d. and 6d. nails.

b. Use a framing square to get the crate square and true.

c. Notice that the end gate is not nailed fast, but is held by a floor cleat and a plug.

Concrete Feeding Floor

1. *Purpose.* Concrete feeding floors have many advantages. Hogs and cattle fed on concrete floors do not waste food as is true in muddy barnyards. The animals are kept in a more sanitary condition. Another saving is effected by having a drainage gutter in connection with the feeding floor which runs directly to a concrete manure pit. In this way the loss which ordinarily results in the average barnyard from the leaching of manure is prevented.
2. *Location.* The feeding floor may well be located on the protected side (opposite to side from which severe winter storms come) of a

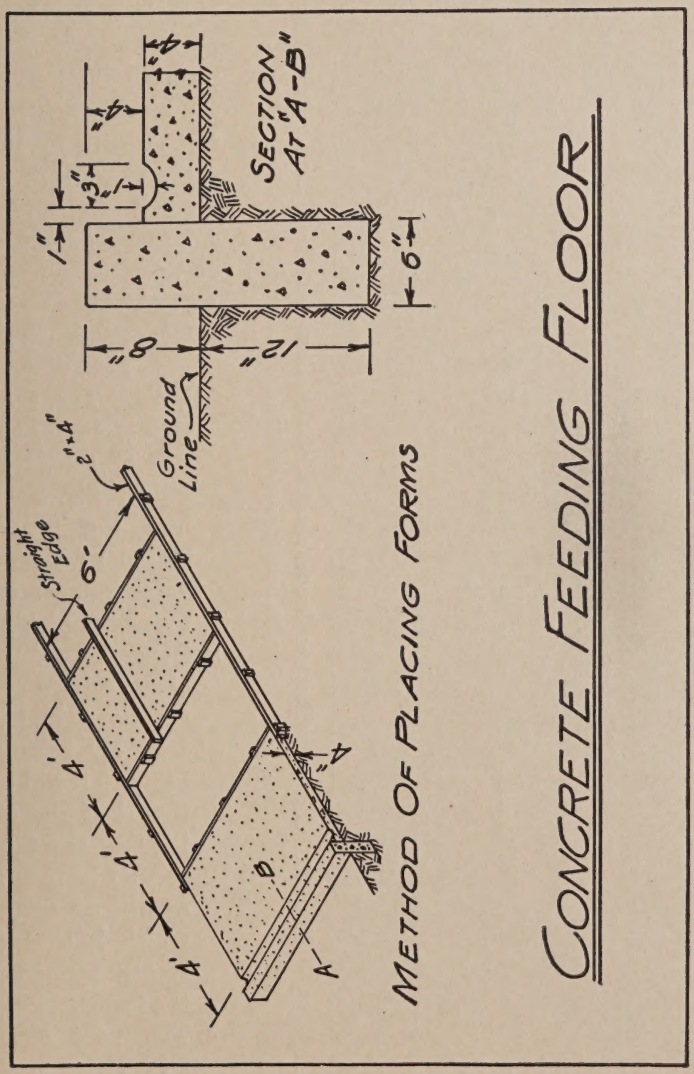


FIG. 120. CONCRETE FEEDING FLOOR

hog house or corn crib. The ground upon which the floor is built should have sufficient fall to ensure good drainage. A slope of ¼″ per foot is sufficient.

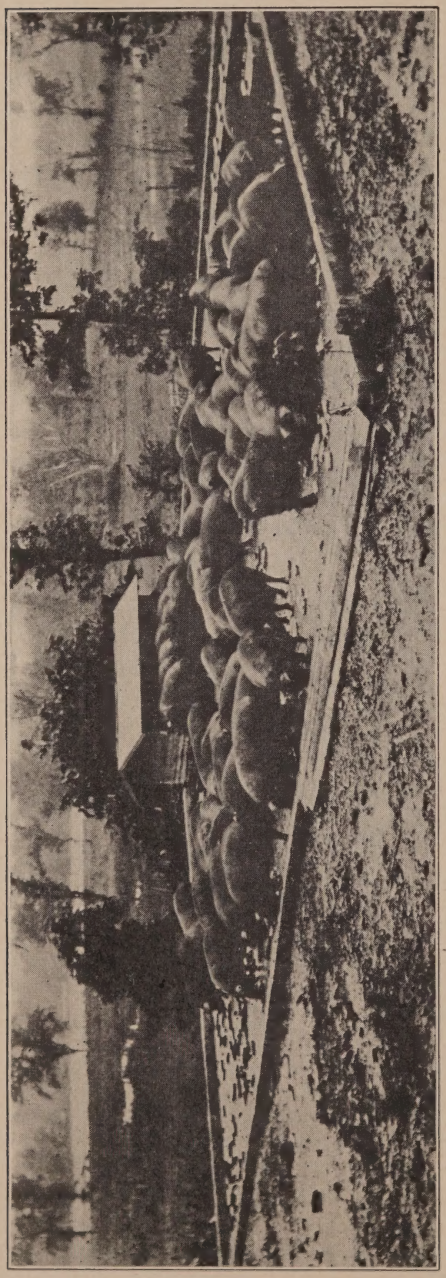


FIG. 121. CONCRETE FEEDING FLOOR AND SELF-FEEDER ON MR. C. A. ROTTGERING'S FARM, PADUCAH, KY.
Photograph, courtesy of the Portland Cement Association.

3. *Size and shape of feeding floor.* Feeding floors may be built in any desired shape, but the square floors are preferred by most farmers.

A projecting curb and gutter, as shown in Fig. 120, is desirable. The curb keeps hogs from pushing their food into the mud. Each 10 lineal feet of curb requires 2¼ sacks of cement, 4½ cubic feet of sand, and 6¾ cubic feet of stone or pebbles.

4. *Directions.*

a. Concrete feeding floors are not difficult to build. The construction is similar to a series of concrete sidewalks. Fig. 120 shows how the forms are placed so that alternate squares or rectangles are laid.

b. General directions about mixing concrete are given in Chapter III. By referring to Fig. 120 it will be seen that the forms are laid in place, and that each section is then struck off with a straight edge which is shoved in a zigzag fashion across the forms.

c. The floor should be laid off into squares as shown in Fig. 120. These may be as

large as 10′ × 10′, and the joints should extend all the way through the concrete. This allows for expansion. The joints are filled with sand or asphalt. Strips of felt paper are also used.

d. Finish the top of the floor with a wooden float (see Fig. 187) instead of using a steel trowel. The wooden float gives a rougher finish which prevents animals from slipping on the concrete.

e. Several hours after the concrete has been laid, the surface should be protected with straw or litter to prevent the sun from drying it out too quickly. The surface should be kept moist by sprinkling it occasionally. Animals and wagons should be kept off the floor for three weeks.

The following table, taken from *Concrete on the Farm*, published by the Portland Cement Association, gives the size of the floor required for various numbers of hogs, and the amount of material required for a 1 : 2 : 3 mixture, and a slab 4″ thick.

TABLE 13. AREA OF FEEDING FLOORS

NUMBER OF HOGS	MINIMUM SQ. FT. OF FLOOR REQUIRED	SACKS OF CEMENT	CU. YDS. OF SAND	CU. YDS. OF PEBBLES
10	150	13	1	1½
20	300	26	2	3
40	600	52	4	6
60	900	77	5¾	8¾
80	1200	103	7¾	11¾
100	1500	128	9½	14½

Portable "A"-Shaped Hog House

1. *Purpose.* The "A"-shaped house is one that is easy to build, and relatively cheap. It is especially good where it can be moved from place to place so as to keep the surroundings clean, and give pigs or hogs free range. This type of house has proved very satisfactory, and is endorsed by practical swine raisers.

The house shown in Fig. 122 has double doors, each cut into two parts. This makes the house easy to clean and the lower portions of the doors may be closed so as to facilitate the proper handling of sows and pigs. The house is so placed that prevailing storms meet the house on the closed side.

2. *Material required.*

a. *Lumber.* Yellow pine, Douglas fir, etc.

NO. OF PIECES	DIMENSIONS	PURPOSE
3	2″ × 6″ × 9′ 4″	Skids
8	1″ × 12″ × 8′	Floor
2	2″ × 4″ × 8′	Plates
1	2″ × 4″ × 8′	Ridge board
8	2″ × 4″ × 7′ 8″	Rafters
2	2″ × 4″ × 3′ 10″	Bridging

No. of Pieces	Dimensions	Purpose
2	2″ × 4″ × 19″	Bridging
3	2″ × 6″ × 8′	Fenders
7	2″ × 4″ × 10″	Fender brackets
16	1″ × 12″ × 7′ 8″	Roof boards
14	1″ × 4″ × 7′ 8″	Battens
150 lineal feet	1″ × 12″ random lengths	End
140 lineal feet	1″ × 4″ random lengths	End
24 lineal feet	1″ × 4″ random lengths	Battens for doors

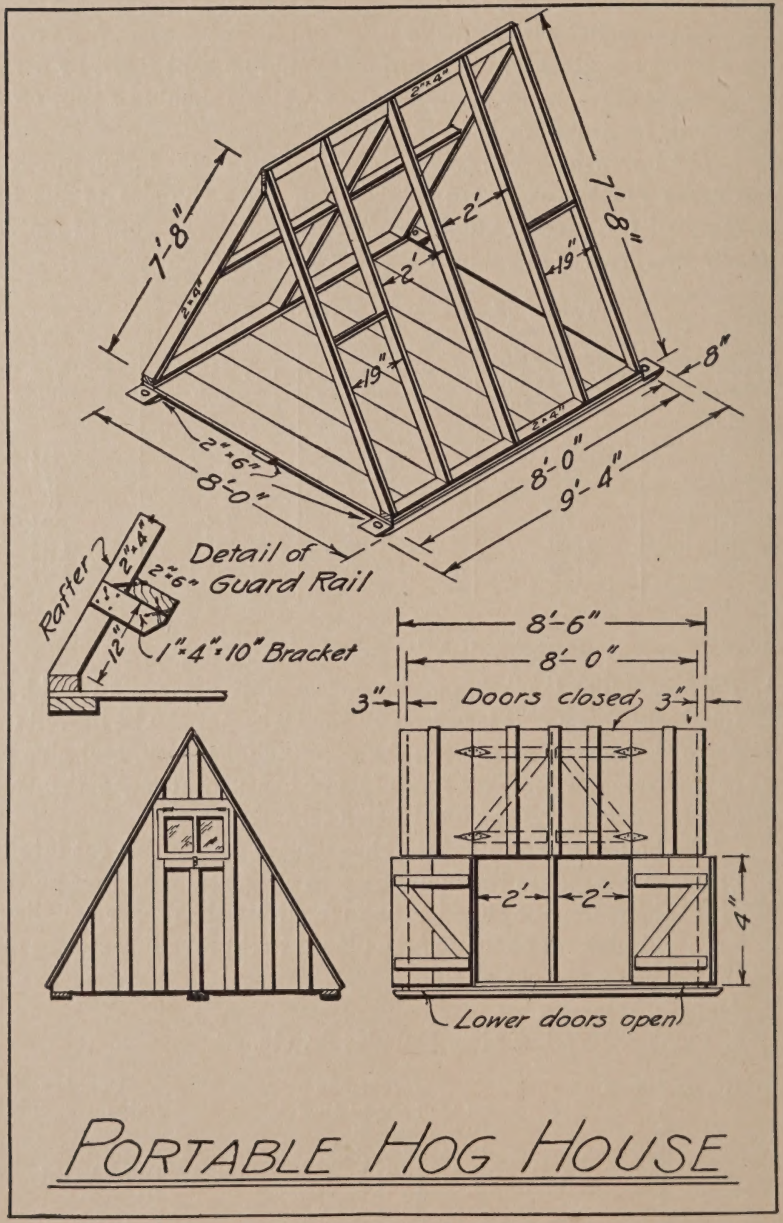


Fig. 122. Portable Hog House

b. *Hardware.*

4 pairs 12″ strap hinges with screws.
2 pairs 3″ butt hinges for windows.
2 simple door pulls.
10 lbs. 8d. common wire nails.
2 lbs. 16d. common wire nails.

c. *Other materials.*

2–2 light window sash 8″ × 10″ lights.
1 gal. paint (for two coats).

3. *Directions.* For method of getting the proper cuts for the rafters see Figs. 196 and 197.

a. The house may be covered with boards and with battens, or with other material, such as ship-lap and tar-paper, or with sheathing and cedar shingles as in Fig. 123.

FIG. 123. AN "A"-SHAPED HOG HOUSE

Built by agricultural pupils at Chippewa Falls, Wis. Photograph from G. W. Gehrand, State Supervisor of Agricultural Education, Madison, Wis.

b. The interior guard rail or fenders go on the back and the two ends. Owing to the pitch of the roof, the fender may be placed on the ends only, or permanent fenders may be placed on the ends with a removable one for the back of the house.

c. Arrange the windows so that they may be kept open during warm weather.

The Iowa Gable-Roof House [1]

1. *Purpose.* This hog house is of the movable type. It has been successfully used by the Iowa Agricultural Experiment Station for many years. It is substantial, attractive, and well designed. Fig. 127 shows the house as it is used for summer service, and Fig. 128 gives a rear view showing the ventilator that is used at times. The general construction can be seen from these views and from the drawings.

2. *Construction details.*

a. Runners should be of fir, cypress, chestnut, or other durable wood.

[1] Reproduced by permission from Bulletin 152, *Movable Hog Houses*, Agricultural Experiment Station, Iowa State College.

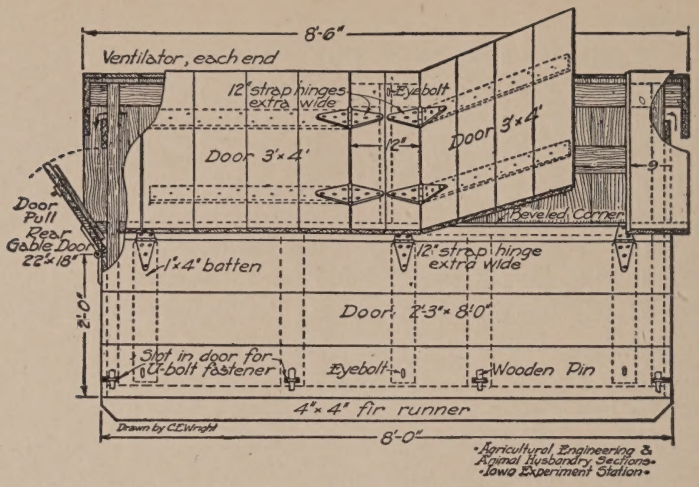


FIG. 124. SIDE VIEW OF IOWA GABLE-ROOF HOUSE

b. Two-inch flooring is better than flooring 1″ thick. The flooring can be omitted if desired.

c. Ship-lap makes a satisfactory covering for the house.

d. The entrance door may be placed in the gable end or near one corner at the side, the latter position being preferable, as it protects the swine more from drafts. The door may have to be made 6″ higher than specified.

e. The roof doors should have an east exposure if the entrance door is on the south end. When the entrance door is in the east corner of the south side wall, the roof doors should be on the same side.

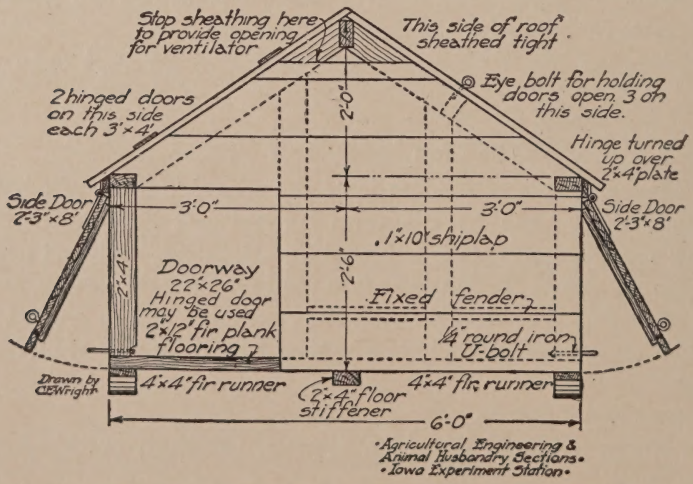


FIG. 125. FRONT END VIEW OF IOWA GABLE-ROOF HOUSE

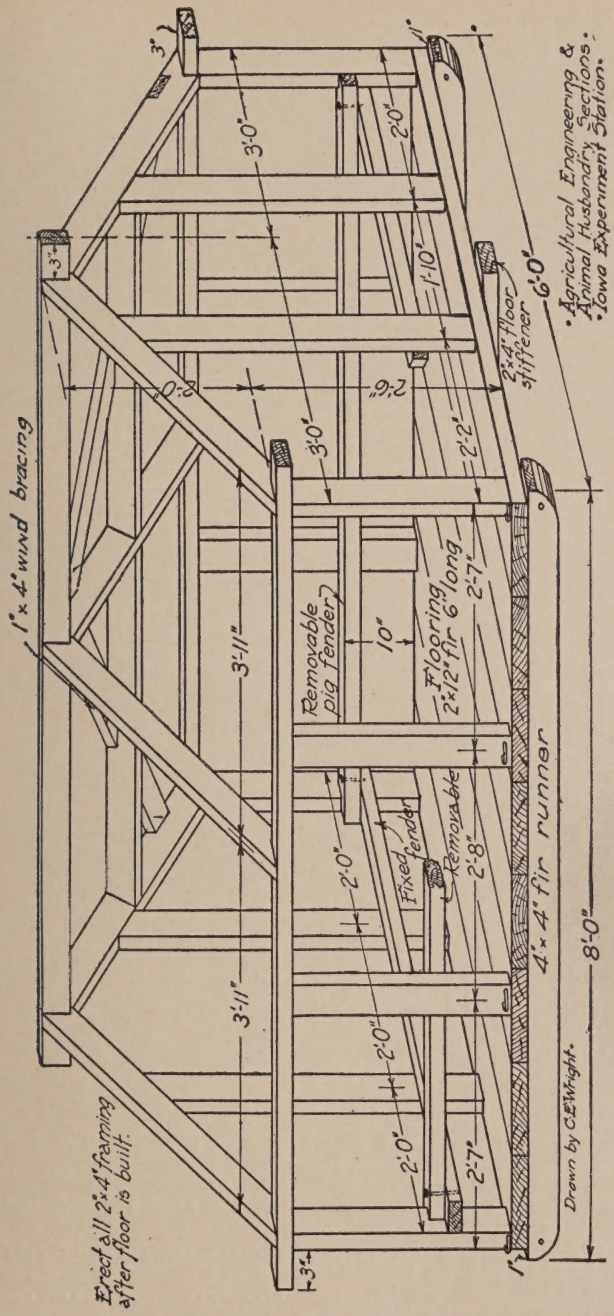


FIG. 126. IOWA GABLE-ROOF HOUSE SHOWING FRAMING DETAILS

f. Small end doors for ventilation are desirable.

g. Shade doors as provided in this house are exceedingly useful in hot weather.

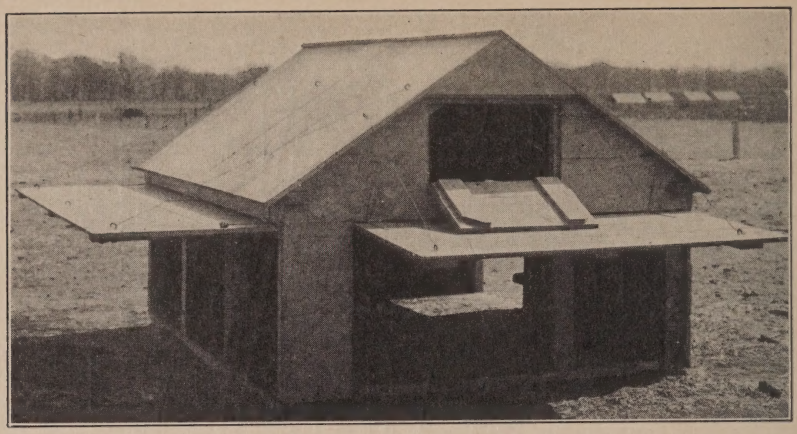


FIG. 127. IOWA GABLE-ROOF HOUSE IN SUMMER SERVICE

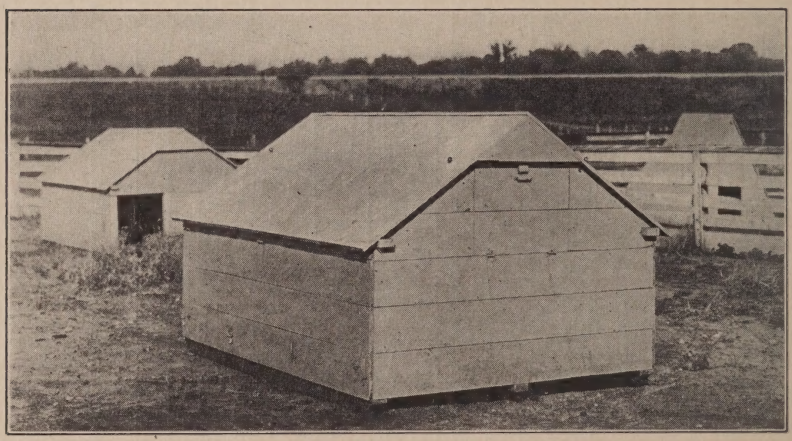


FIG. 128. IOWA GABLE-ROOF HOUSE, REAR VIEW; CLOSED

Note ventilator at peak.

h. Build permanent fenders on the ends, and removable ones on the sides of the house.

i. Build a ventilator by leaving a moderate-sized opening at the ridge pole, and protect same by nailing a wide board under and flush with the extending roof boards. (See Fig. 128.)

3. *Bill of material and estimate of cost.*

1 piece 4″ × 4″ × 16′ for runner, fir, 21⅓ board feet @ $55 per M	$ 1.17
4 pieces 2″ × 12″ × 12′ for floor, No. 1 white or yellow pine, 96 board feet @ $30 per M	2.88
1 piece 2″ × 4″ × 8′ for floor stiffeners, No. 1 white or yellow pine, 5⅓ board feet @ $28 per M	.15
3 pieces 2″ × 4″ × 8′ for rafters, No. 1 white or yellow pine.	
1 piece 2″ × 4″ × 8′ for girt, No. 1 white or yellow pine.	
1 piece 2″ × 4″ × 10′ for ridge, No. 1 white or yellow pine.	
2 pieces 2″ × 4″ × 10′ for plates, No. 1 white or yellow pine.	
*2 pieces 2″ × 4″ × 8′ for studs, No. 1 white or yellow pine.	
*2 pieces 2″ × 4″ × 10′ for studs, No. 1 white or yellow pine.	

2 pieces 2″ × 4″ × 8′ for fender, No. 1 white or yellow pine.	
1 piece 2″ × 4″ × 10′ for fender, No. 1 white or yellow pine.	
82⅔ board feet @ $28 per M	$2.32
1 piece 1″ × 4″ × 12′ for brace, No. 1 white or yellow pine, 4 board feet @ $30 per M	.12
3½ pieces 1″ × 10″ × 12′ No. 1 white or yellow pine for ends.	
*5 pieces 1″ × 10″ × 16′ for ship-lap for ends and sides, No. 1 white or yellow pine.	
1 piece 1″ × 8″ × 8′ No. 1 white or yellow pine.	
3 pieces 1″ × 10″ × 10′ No. 1 white or yellow pine.	
114½ board feet @ $30 per M	3.44
11 pieces 1″ × 10″ × 8′ ship-lap for roof, white or yellow pine, 72⅔ board feet @ $30 per M	2.21
3 pieces 1″ × 4″ × 16′ for bottoms, 16 board feet @ $30 per M	.48
12 eyebolts @ 5c	.60
8 U-bolts @ 8c	.64
5 pair 12″ strap hinges @ 22c	1.10
1 pair 8″ strap hinges @ 18c	.18
1 door pull	.10
1 wire for holding door open	.10
12.5 lbs. nails @ 4c	.50
.60 gallon to paint double coat 150 sq. ft. @ $2.00 per gallon	1.20
Cost of material	$17.19
Labor, 15 hours @ 25c	3.75
Total cost	$20.94

* *Note:* If the sides of the house are built higher than specified to allow of large doorway for tall swine, make due additions in lumber.

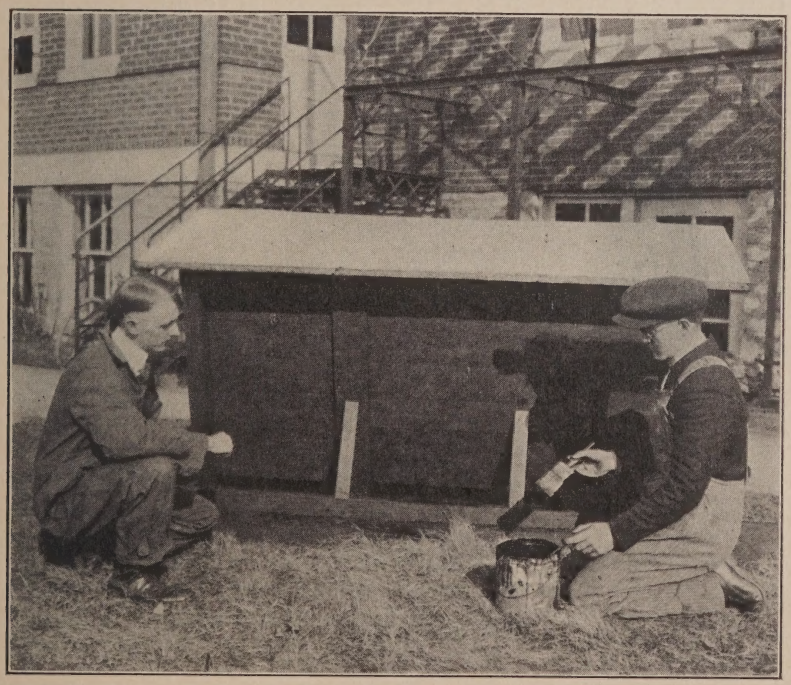


FIG. 129. THE OHIO SELF-FEEDER FOR HOGS

Built by high-school boys from plans furnished by the School of Agriculture, Ohio State University. Photograph, courtesy of Mr. H. P. Twitchell, Agricultural Extension Department, Ohio State College.

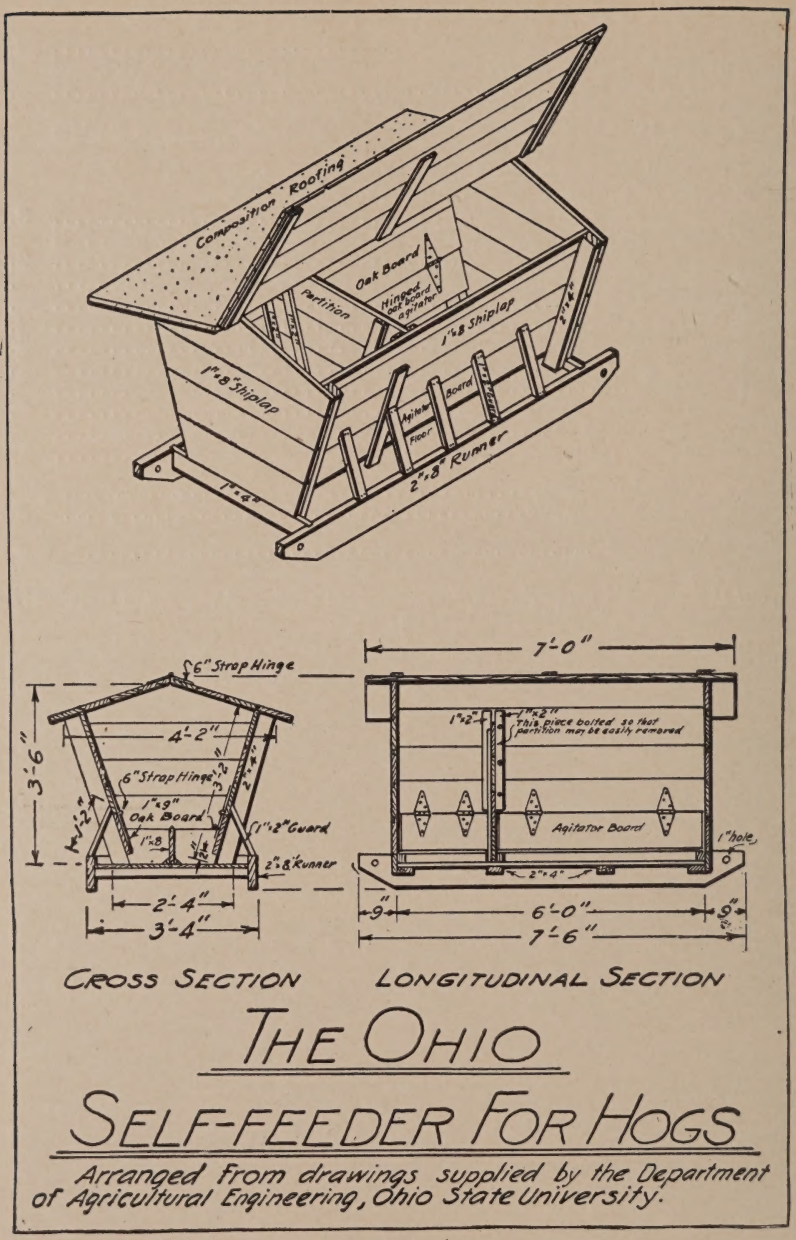


FIG. 130. THE OHIO SELF-FEEDER FOR HOGS

The Ohio Self-Feeder for Hogs

1. *Purpose.* A self-feeder is essentially a box or hopper into which grain or other dry feed is poured, and which is so constructed as to

make this feed available to animals at all times without at the same time wasting any of it. The purpose of a self-feeder, then, is to save labor, and feed.

The Ohio self-feeder for hogs has demonstrated its value as a labor-saving device. It is used by many successful swine raisers.

2. *Material required.*

a. *Lumber.* Cypress, fir, western red cedar, yellow pine, etc.

No. of Pieces	Dimensions	Purpose
7	1″ × 8″ × 14′	Ship-lap
8	1″ × 8″ × 12′	Ship-lap
1	2″ × 4″ × 14′	Framing
1	2″ × 4″ × 12′	Framing
2	2″ × 8″ × 8′	Runners
2	1″ × 2″ × 12′	
1	1″ × 8″ × 6′	Center board
2	1″ × 9″ × 12′	(Hard wood agitator
1	1″ × 4″ × 8′	board)

Fig. 131. Self-Feeders for Hogs

Photograph, courtesy of Mr. E. G. Russell, Specialist in Swine Husbandry, U.S. Bureau of Animal Industry, Department of Agriculture, Washington, D.C.

b. *Hardware.*

5 pair 6″ strap hinges.
6 2″ × ⅜″ bolts.
3 lbs. 8d. common wire nails.
1 lb. 20d. common wire nails.

c. *Other material.*

37 sq. ft. prepared roofing with nails.
1 gal. paint.

3. *Directions.*
   a. By following the drawings, the list of material, and by noting Fig. 130, it will be relatively easy to build the self-feeder. First assemble the skids and cross-ties, and then the upper framework.
   b. Ship-lap makes a good and economical sheathing material, and is satisfactory for the floor as well.
   c. The agitator boards should be of strong wood, such as oak.

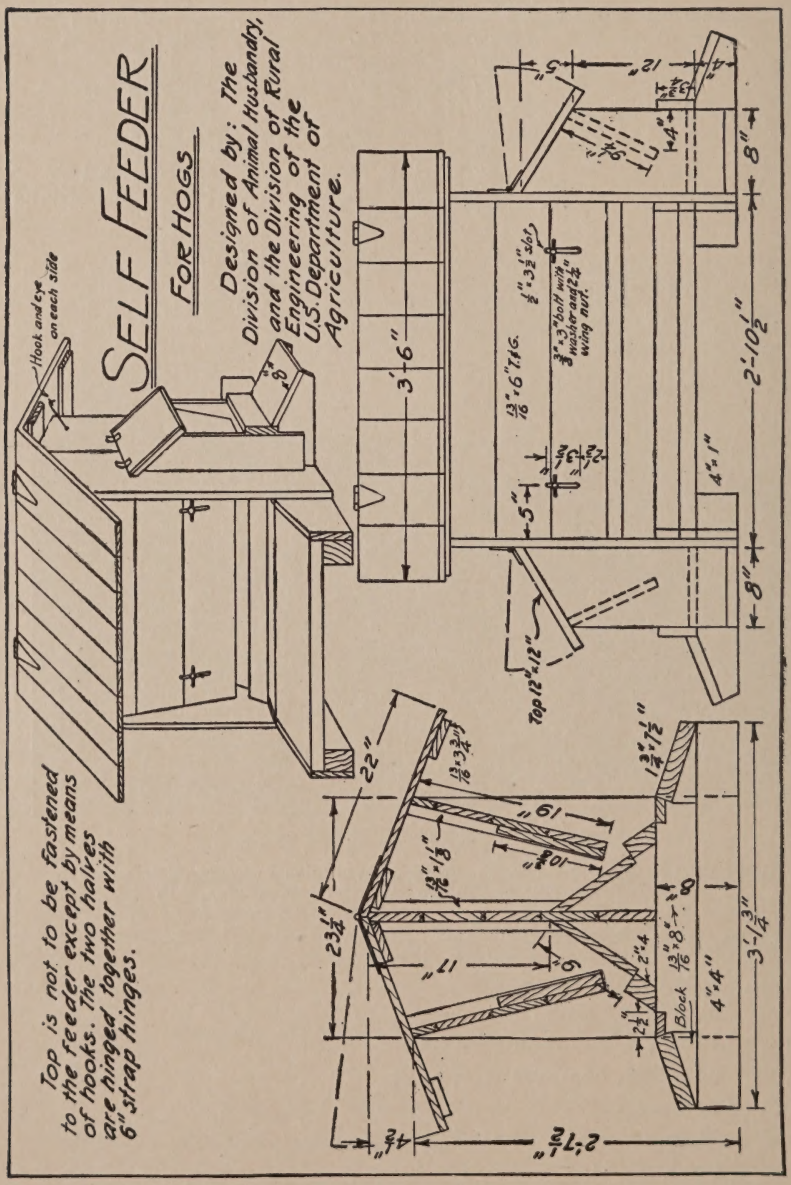


FIG. 132. SELF-FEEDER FOR HOGS

d. Apply the prepared roofing on a sunny day if possible. Lay the material on the self-feeder and let it expand for several hours in the warm sun before fastening it down. This will prevent unsightly buckling.

Self-Feeder for Hogs[1]

(Recommended by the United States Department of Agriculture)

1. *Purpose.* The self-feeder shown in Fig. 132 is built along good lines and is giving satisfaction. It is somewhat smaller than the Ohio self-feeder.
2. *Material required.*

Lumber. Fir, cypress, cedar, yellow pine, etc.

No. of Pieces	Dimensions
36 sq. ft.	$^{13}/_{16}'' \times 6''$ (tongued and grooved)
4 pcs.	$1'' \times 12'' \times 3'$
2	$1'' \times 10\frac{3}{8}'' \times 3'$
2	$1'' \times 9'' \times 3'$
2	$2'' \times 4'' \times 3'$
2	$1'' \times 2\frac{1}{2}'' \times 3'$
2	$1\frac{3}{4}'' \times 7\frac{1}{2}'' \times 3'$
2	$4'' \times 4'' \times 3'\ 1\frac{3}{4}''$
8 lineal feet	$^{13}/_{16}'' \times 1\frac{1}{8}''$

Side Hoppers.

No. of Pieces	Dimensions
1	$1'' \times 8'' \times 8'$
1	$1'' \times 12'' \times 2'$
1	$9\frac{1}{4}'' \times 16'$
3	$^{13}/_{16}'' \times 3\frac{3}{4}'' \times 7'$

Hardware.

1 pr. 6″ strap hinges.
1 pr. 2″ hinges.
2 6″ hooks and eyes.
2 ⅜″ × 3″ bolts with wing nuts and washers.
2 lbs. 8d. common wire nails.
1 lb. 6d. common wire nails.
½ lb. 8d. finishing nails.

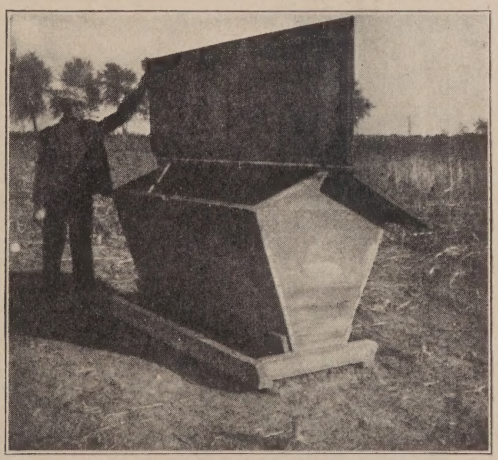


Fig. 133. Self-Feeder for Hogs

Made by agricultural pupils at Kirksville, Mo. Photograph, courtesy of Mr. W. T. Spanton, State Supervisor of Agricultural Education, Jefferson City, Mo.

3. *Directions.*
   a. The roof boards run up and down rather than lengthwise of the roof.

[1] Plans and photograph supplied by E. G. Russell, specialist in Swine Husbandry, U.S. Bureau of Animal Industry.

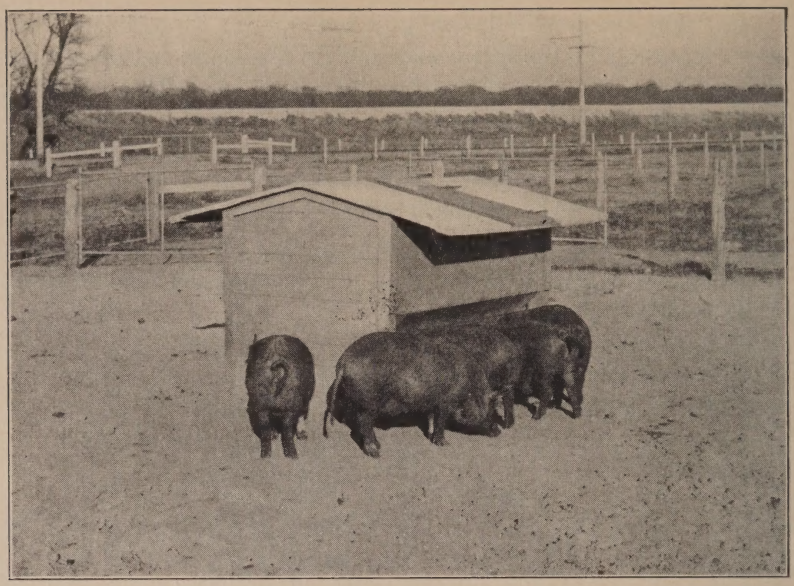


FIG. 134. THE IOWA FEEDER NO. D257

Photograph, courtesy of Professor W. A. Foster, Department of Animal Husbandry, Iowa State College, Ames, Iowa.

b. The roof is not to be nailed down, but is simply hooked fast to the body of the feeder.

c. A "T" hinge or a 6″ strap hinge may well be used for the lid of

FIG. 135. A GOOD SMOKEHOUSE

Photograph, courtesy of Mr. Wm. C. Skelley, Agricultural Experiment Station, New Brunswick, N.J.

the side hoppers. The longer hinges would tend to keep the lid from breaking.

d. Prepared roofing may be put on the roof if desired.

Smokehouse

1. *Type of structure.* The construction of smokehouses varies greatly. Persons who have only small quantities of meat to cure may hang it in a barrel into which smoke is introduced by a stovepipe from a fire built near by.

   On farms where considerable meat is cured, it pays to build a permanent building such as shown in Fig. 135.

2. *Essential features.* A good smokehouse should be fireproof and vermin and insect proof. It should be high enough so that the meat may be hung 6′ or 8′ above the fire.

REFERENCES

1. *Free bulletins and circulars.*
   Concrete on the Farm. Portland Cement Association.
   Concrete Feeding Floors. Portland Cement Association.
   Community Hog Houses. Davidson, J. B., Evvard, J. M., and Kaiser, W. G. Bulletin 166, 1916, Agricultural Experiment Station, Ames, Iowa.
   Dry Lot vs. Pasture Crop for Growing Pigs with a Self-Feeder. Havner, H. H., and Gerlaugh, Paul. Separate No. 5. Reprint from Annual Report for 1915–16, Agricultural Experiment Station, State College, Pennsylvania.
   Handy Equipment for Swine Raising. Kaiser, W. G., and Evvard, John M. Circular No. 69, Agricultural Experiment Station, Ames, Iowa.
   Hog Houses. Warren, J. A. Farmers' Bulletin 438.
   Home Butchering and Curing of Pork. Hunter, J. M. Circular 101, Agricultural Experiment Station, New Brunswick, N.J.
   Home Curing of Pork. Simms, J. A. Extension Bulletin No. 11, 1917, Connecticut Agricultural College.
   Movable Hog Houses. Evvard, John M., and Davidson, J. B. Bulletin No. 152, 1916, Agricultural Experiment Station, Ames, Iowa.
   Movable Hog Houses. McVean, J. D., and Hutton, R. E. Circular 102, February, 1918, U.S. Department of Agriculture.
   Raising Pigs. Allen, Howard B. Junior Extension Bulletin 5, 1920, Cornell University College of Agriculture, Ithaca, N.Y.
   Raising Pigs. Wright, F. L. Circular 77, 1920, University of Missouri College of Agriculture, Columbia, Mo.
   Self-Feeders for Hogs. Bohstedt, G. Extension Circular 119, College of Agriculture, University of Wisconsin, Madison.
   Simple Hog Breeding Crate. Zellar, J. H. Farmers' Bulletin 966.
   Sunshine and Sanitation for Hog Houses. Foster, W. A., and Evvard, John M. Bulletin 194, Agricultural Experiment Station, Ames, Iowa.
   Swine Feeding and Management. Tomhave, W. H., and Havner, H. H. Extension Circular 77, 1919, Pennsylvania State College, State College, Pennsylvania.
   Swine Husbandry in Oregon. Withycombe, James, and Potter, E. L. Circular Bulletin No. 18, 1911, Agricultural Experiment Station, Corvallis, Oregon.
2. *Text and reference books.*
   Day, George E. *Productive Swine Husbandry.* J. B. Lippincott Co.
   Harper, M. W. *Animal Husbandry for High Schools,* Macmillan Co.
   Harper, M. W. *Manual of Farm Animals.* Macmillan Co.
   Plumb, Chas. S. *Beginnings in Animal Husbandry.* Webb Publishing Co.

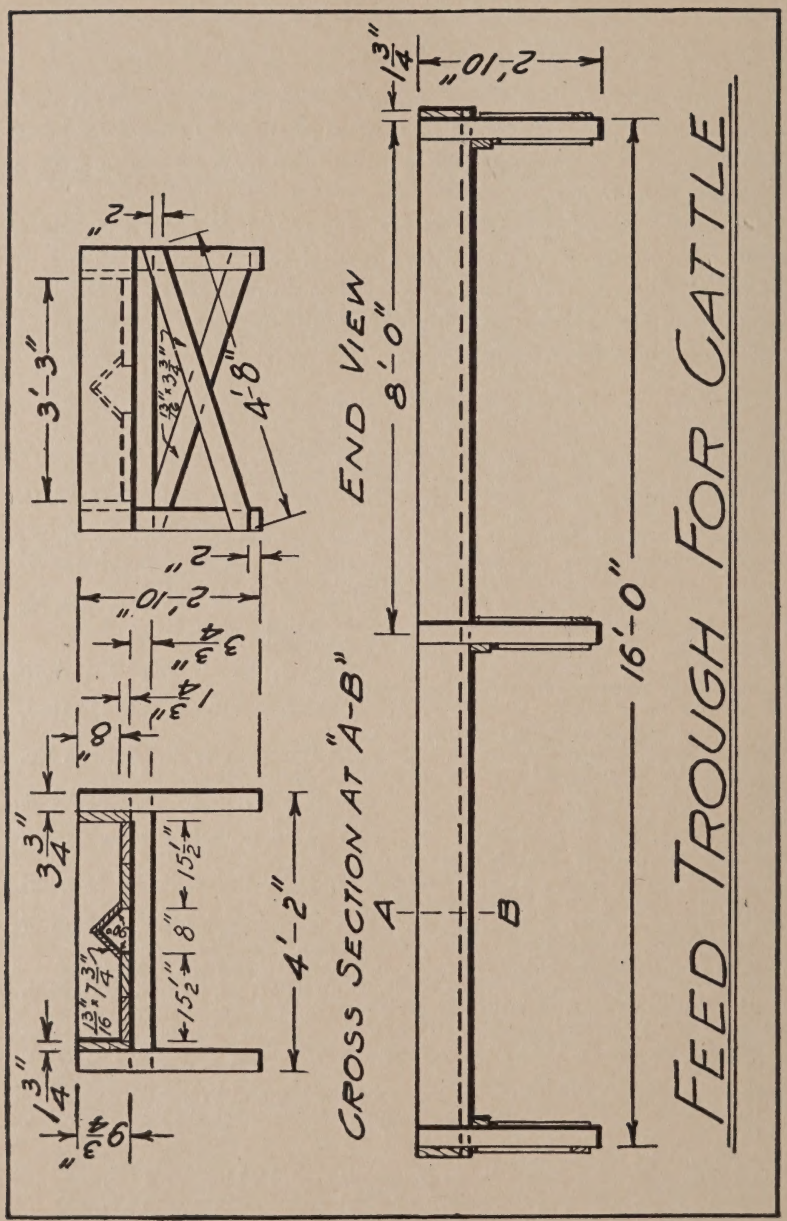


Fig. 136. Feed Trough for Cattle

CHAPTER X

RELATING TO CATTLE HUSBANDRY

MANY farmers find it profitable to raise a certain number of beef cattle, or to keep such cattle at certain seasons of the year. Thousands of young beef cattle are taken from the ranges of the United States and Canada, and are sold to farmers in more densely settled sections who buy them for "winter feeders." They dispose of by-products, such as straw and corn fodder, by feeding them, and utilize their time more fully during the winter months. Such a practice also helps to maintain soil fertility. The projects given herewith are widely used in cattle husbandry.

Feed Trough for Cattle

1. *Purpose.* The feed trough shown in Fig. 136 is built for feeding corn or other concentrates to cattle. The trough is built in a substantial manner, as cattle are inclined to push or crowd against it. The division boards running lengthwise of the center are a desirable feature. The trough is portable so that its location can be changed as desired.
2. *Material required.*
   a. *Lumber.* Yellow pine, fir, cypress, etc.

FIG. 137. FEED TROUGH USED AT THE SCHOOL OF AGRICULTURE, PURDUE UNIVERSITY

Photograph, courtesy of the Department of Animal Husbandry, Purdue University.

No. of Pieces	Dimensions	Purpose
6	3¾″ × 3¾″ × 2′ 10″	Legs
2	1¾″ × 9¾″ × 16′	Sides
2	1¾″ × 9¾″ × 4′ 2″	Ends
2	13/16″ × 7¾″ × 16′	Division boards
4	1¾″ × 7¾″ × 16′	Bottom
6	13/16″ × 3¾″ × 4′ 8″	Braces
3	1¾″ × 3¾″ × 4′ 2″	Ties

b. *Hardware.*

3 lbs. 16d. wire nails.

1 lb. 8d. wire nails.

3. *Directions.*

a. Select lumber with vertical or comb grain for the trough, as such lumber will not splinter readily, and wears better than flat or slash grained lumber.

b. Nail all parts securely. Bracing may be used lengthwise as well as crosswise.

c. Use surfaced lumber throughout.

Fig. 138. Loading Chute for Hogs, Sheep, and Cattle on the Farm of P. G. Flynn, Xenia, Ohio

Photograph by Portland Cement Association.

Stock-Loading Chute

1. *Purpose.* Many farmers have occasion to load and unload stock ranging in size from young pigs and lambs to mature cattle into wagons, trucks, or cattle cars. The stock-loading chute shown in Fig. 139 serves as a general purpose chute. It is strong, and the side boards are so placed that young stock cannot go between them. The chute is put on skids that are rounded off at both ends so that it may be pulled in either direction.

2. *Material required.*

a. *Lumber.* Rough lumber of medium price may be used.

No. of Pieces	Dimensions	Purpose
2	2″ × 4″ × 3′ 9″	Posts
2	2″ × 4″ × 4′ 10″	Posts
2	2″ × 4″ × 5′ 11″	Posts
5	2″ × 4″ × 3′ 10″	Cross-ties
2	2″ × 6″ × 7′	Skids
3	2″ × 12″ × 7′ 3″	Floor
8	1″ × 1¾″ × 3′	Floor cleats
2	1″ × 12″ × 7′ 3″	Sides
4	1″ × 8″ × 7′ 3″	Sides

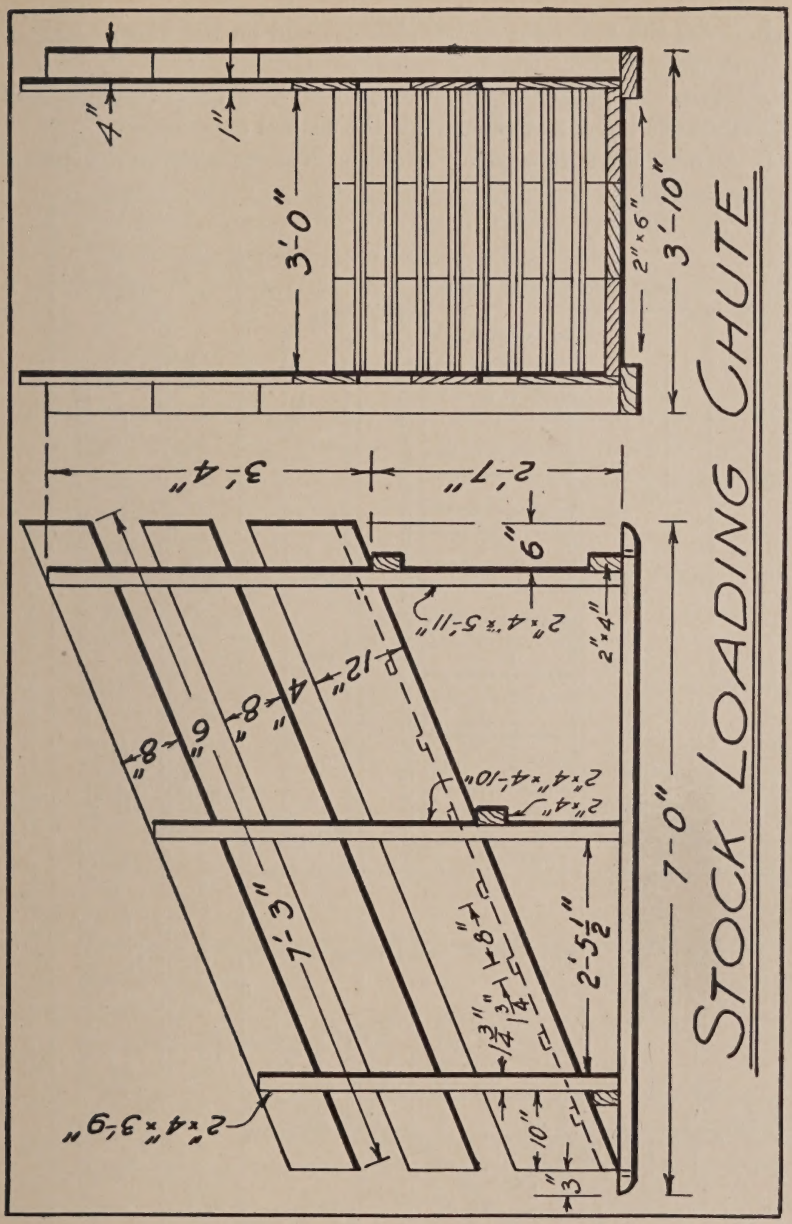


FIG. 139. STOCK-LOADING CHUTE

b. *Hardware.*

3 lbs. 8d. common wire nails.

2 lbs. 16d. common wire nails.

3. *Directions.*

a. Erect the six posts on the skids. Plumb them and brace them temporarily to keep them plumb.

b. Spike the cross-ties on the shortest and on the longest pair of posts.

c. Select straight 1″ × 12″ side boards, tack them in place, and thus get the correct height for the central cross-tie.

d. An easy and sure way to get the end cuts correctly on the sides is

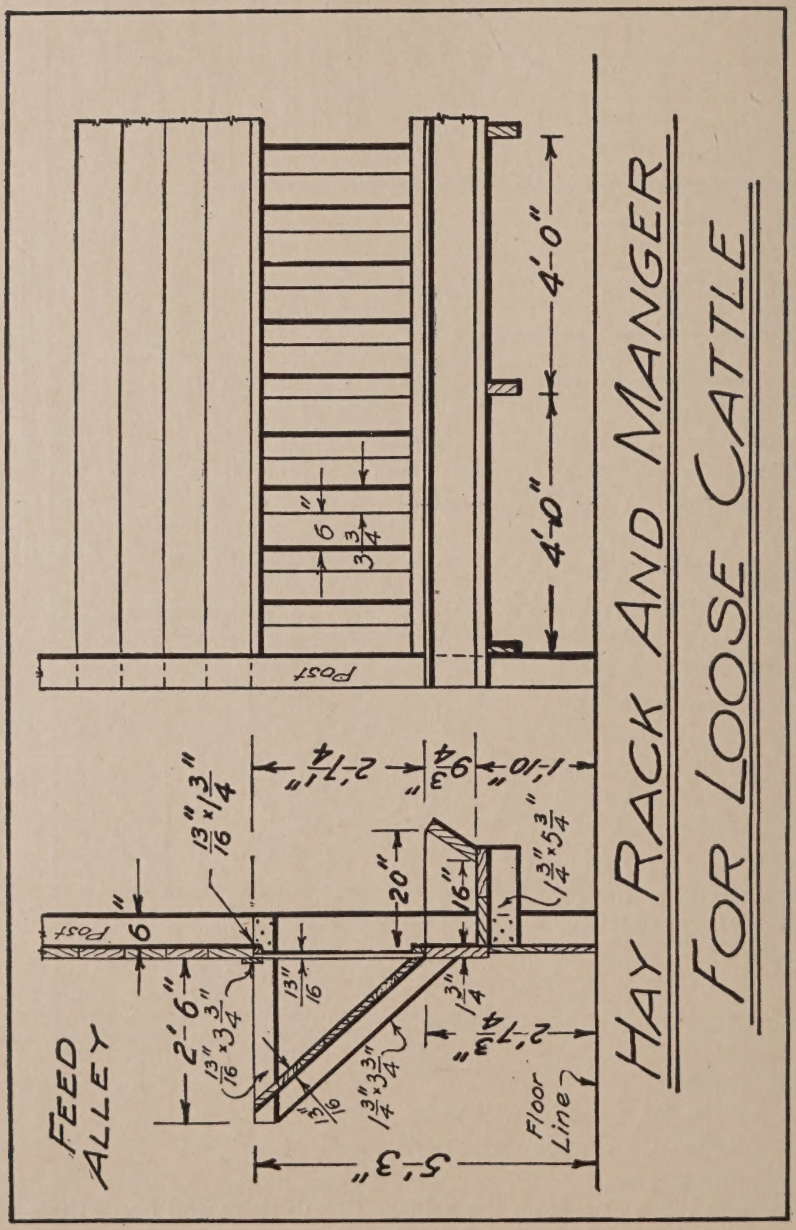


FIG. 140. HAY RACK AND MANGER FOR LOOSE CATTLE

to nail the latter fast, making sure that there is enough projection on each end. Then use a plumb-bob or a level to get the vertical cuts, and saw them to the lines thus obtained.

Another way is to use the framing square. The rise is 2′ 7″ and the run is 6′ 3″. Figure the rise per 24″ of run.

e. Bore ¾″ or 1″ holes in the skids at both ends. Baling wire may be passed through these holes to serve as a means of fastening the doubletree when the chute is to be moved.

f. When not in use, place cleats under the skids to keep them off the ground.

Hay Rack and Manger for Loose Cattle

1. *Purpose.* A "free-for-all" hay rack and manger without separate stalls or partitions is frequently desirable especially where the animals are well graded. Young heifers and baby beeves can be fed economically in this way.

2. *Material required* (for a section 12′ long).

a. *Lumber.* Yellow pine, fir, cypress, etc., all surfaced.

No. of Pieces	Dimensions	Purpose
2	6″ × 6″ (or larger)	Posts
4	1¾″ × 5¾″ × 16″	Brackets
2	1¾″ × 9¾″ × 12′	Bottom of manger
1	1¾″ × 11¾″ × 12′	Back of manger
1	1¾″ × 11¾″ × 12′	Front of manger
30 lineal feet	1¾″ × 3¾″	Framing for hay rack
60 sq. feet	13/16″ × 6″ or 8″	Ship-lap sheathing for hay rack
2	13/16″ × 11¾″	Ship-lap sheathing below hay rack
14	13/16″ × 3¾″ × 2′ 8″	Slats for hay rack
1	13/16″ × 3¾″ × 12′	Trim
2	13/16″ × 1¾″ × 12′	Trim

Sheathing if desired above hay rack to be figured in addition to the above.

b. *Hardware.*

2 lbs. 16d. common wire nails.
3 lbs. 8d. common wire nails.
1 lb. 8d. finishing nails.

3. *Directions.*

a. In selecting lumber for the trough, pick out planks having a vertical grain.

b. The slats for the front of the hay rack are nailed between stops, as shown in the cross-section view. Split hickory or other hardwood sticks may be used, and if old pipe is available, pieces of ¾″ pipe can be used to good advantage.

c. It is always well to drive nail-heads below the surface of the boards where cattle are likely to come in contact with them.

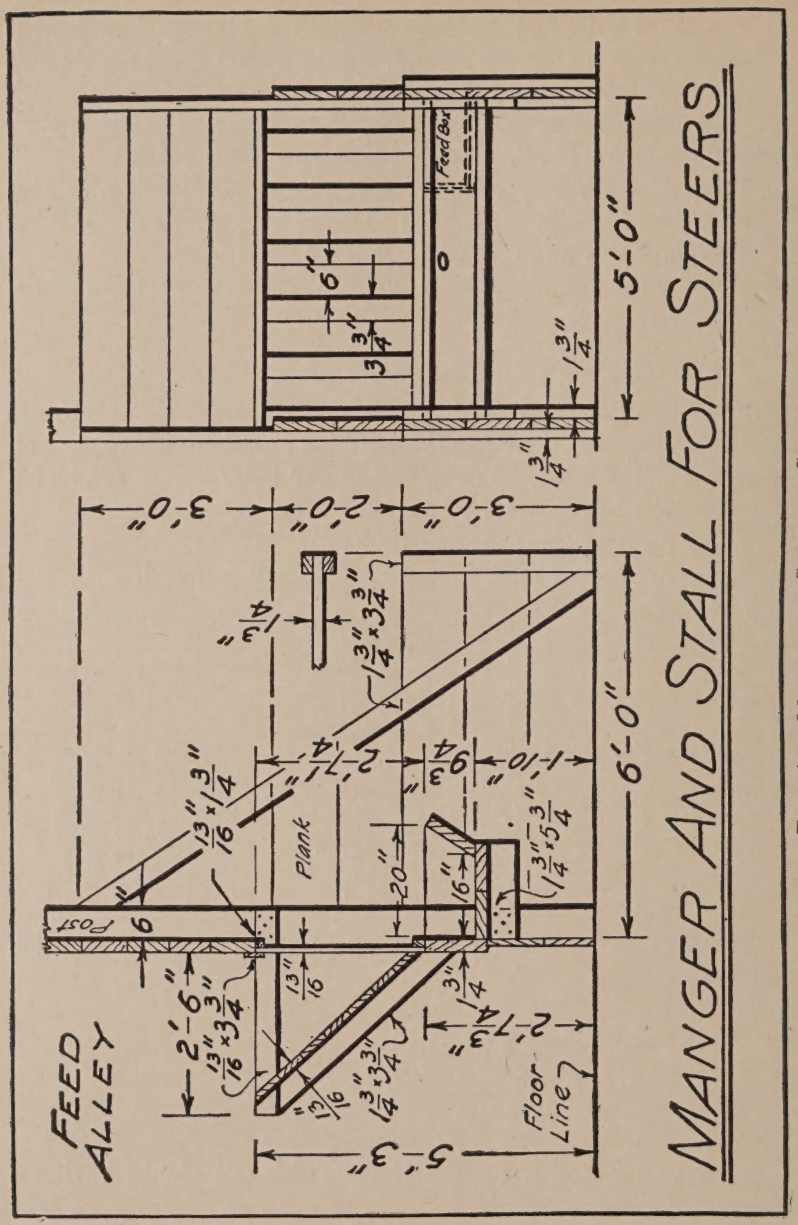


FIG. 141. MANGER AND STALL FOR STEERS

Manger and Stall for Steers

1. *Purpose.* Steers are often kept in separate stalls rather than to give them free access to a manger such as just shown. The stall partitions keep the steers from horning, and otherwise interfering with one another.
2. *Material required.* Essentially the same as for the "hay rack and

manger for loose cattle." Since the construction differs in the addition of stall partitions, the bill of material which follows is for a single partition only.

No. of Pieces	Dimensions	Purpose
2	1¾" × 3¾" × 3'	End posts
1	1¾" × 3¾" × 9'8"	Brace
3	1¾" × 12" × 6'	Partition planks
1	1¾" × 12" × 4'	Partition planks
1	1¾" × 12" × 3'4"	Partition planks

Hardware. 2 lbs. 16d. common wire nails.

3. *Directions.*

a. The partitions are easy to construct. They should vary from 3' to 4' 6" from center to center.

b. The floor should have a slope of 1" per six feet.

REFERENCES

1. *Free bulletins and circulars.*

Barns for Work Animals. Youngblood, B. Bulletin No. 210, 1917, Agricultural Experiment Station, College Station, Texas.

College Farm Buildings. Shaw, R. S., and Jeffery, J. A. Bulletin 250, 1907, Michigan State Agricultural College.

Corn Silage, the Keystone of Economical Cattle Feeding. Skinner, J. H., and King, F. G. Bulletin 235, 1920, Agricultural Experiment Station, Lafayette, Ind.

Farm Buildings. Lewis, Frank C. Circular No. 100, 1921, Experiment Station, Purdue University.

Feeding Baby Beeves. Burns, J. C. Bulletin No. 198, 1916, Agricultural Experiment Station, College Station, Texas.

Ground Soybeans for Fattening Cattle. King, F. G. Bulletin No. 237, 1920, Agricultural Experiment Station, Lafayette, Ind.

Mid-West Branding and Dehorning Chute, The. Campbell, W. H. Engineering Circular, No. 6, 1914, Extension Department School of Agriculture, University of Nebraska, Lincoln, Neb.

Winter Steer Feeding. Skinner, J. H., and King, F. G., Popular Bulletin 163, 1912, Agricultural Experiment Station, Purdue University, Lafayette, Ind.

2. *Text and reference books.*

Shaw, Thomas. *The Management and Feeding of Cattle.* Orange Judd Co., 1918.

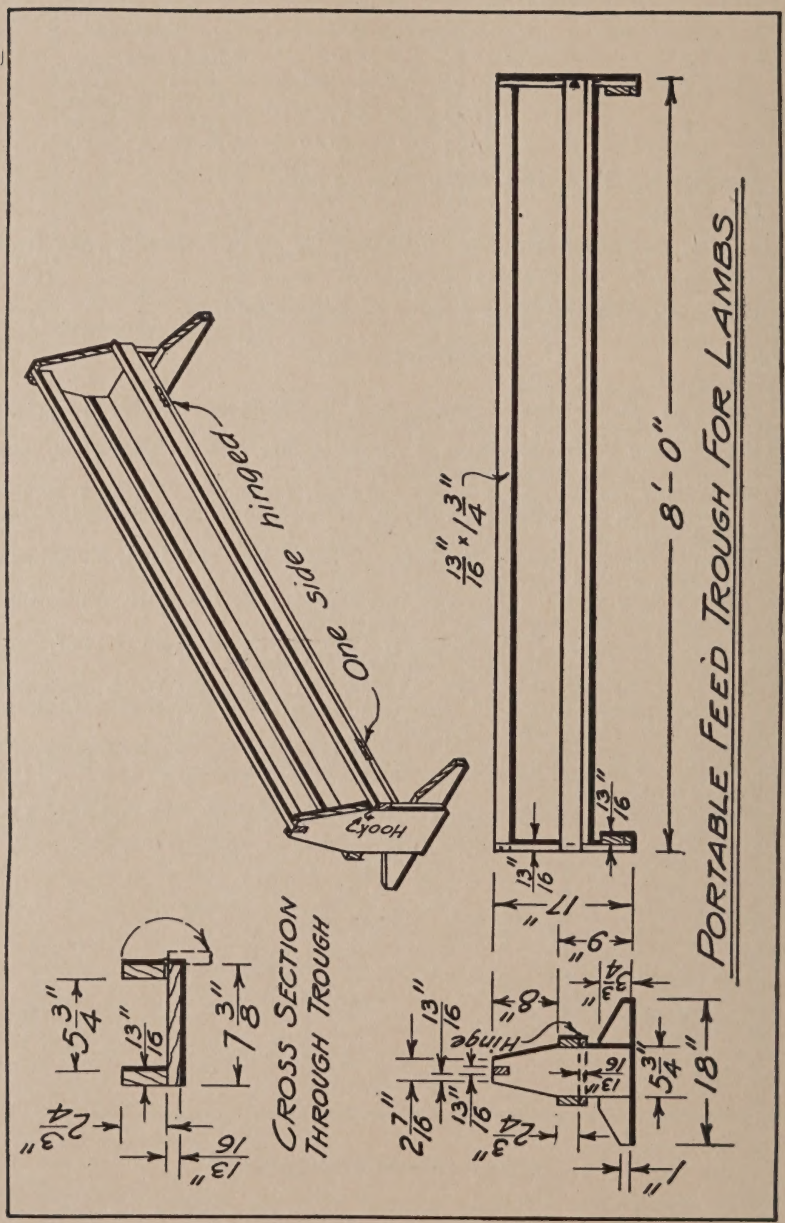


Fig. 142. Portable Feed Trough for Lambs

CHAPTER XI

RELATING TO SHEEP HUSBANDRY

SHEEP raising, like other branches of animal husbandry, is getting to be more and more of a science. A number of labor-saving devices and profit-producing conveniences for sheep husbandry are herewith given. Every one of them has been tested, and has the approval of experienced shepherds.

Portable Feed Trough for Lambs

1. *Purpose.* The portable feed trough shown in Fig. 142 is one that may be used for young lambs. The trough is placed in a creep where it is not accessible to the older stock. Various grain rations may thus be used to supplement ewe's milk and pasture.

   The special features of this trough are:

   a. Simple, light construction.
   b. Wide base to prevent upsetting.
   c. Top rail to prevent animals getting into trough.
   d. Hinged side to make cleaning easy.

2. *Material required.*

   a. *Lumber.* Sound, smooth lumber, preferably of a decay-resisting variety, such as cypress.

FIG. 143. PORTABLE FEED TROUGHS IN USE

(See Farmers' Bulletin No. 1181.) Photograph, courtesy of Mr. D. A. Spencer, Senior Animal Husbandman, Bureau of Animal Industry, U.S. Department of Agriculture.

No. of Pieces	Dimensions	Purpose
1	$^{13}/_{16}'' \times 7\frac{3}{8}'' \times 7'\ 10\frac{3}{8}''$	Bottom
2	$^{13}/_{16}'' \times 2\frac{3}{4}'' \times 8'$	Sides
2	$^{13}/_{16}'' \times 5\frac{3}{4}'' \times 17''$	Ends
2	$^{13}/_{16}'' \times 3\frac{3}{4}'' \times 18''$	Feet
1	$^{13}/_{16}'' \times 1\frac{3}{4}'' \times 8'$	Top Rail

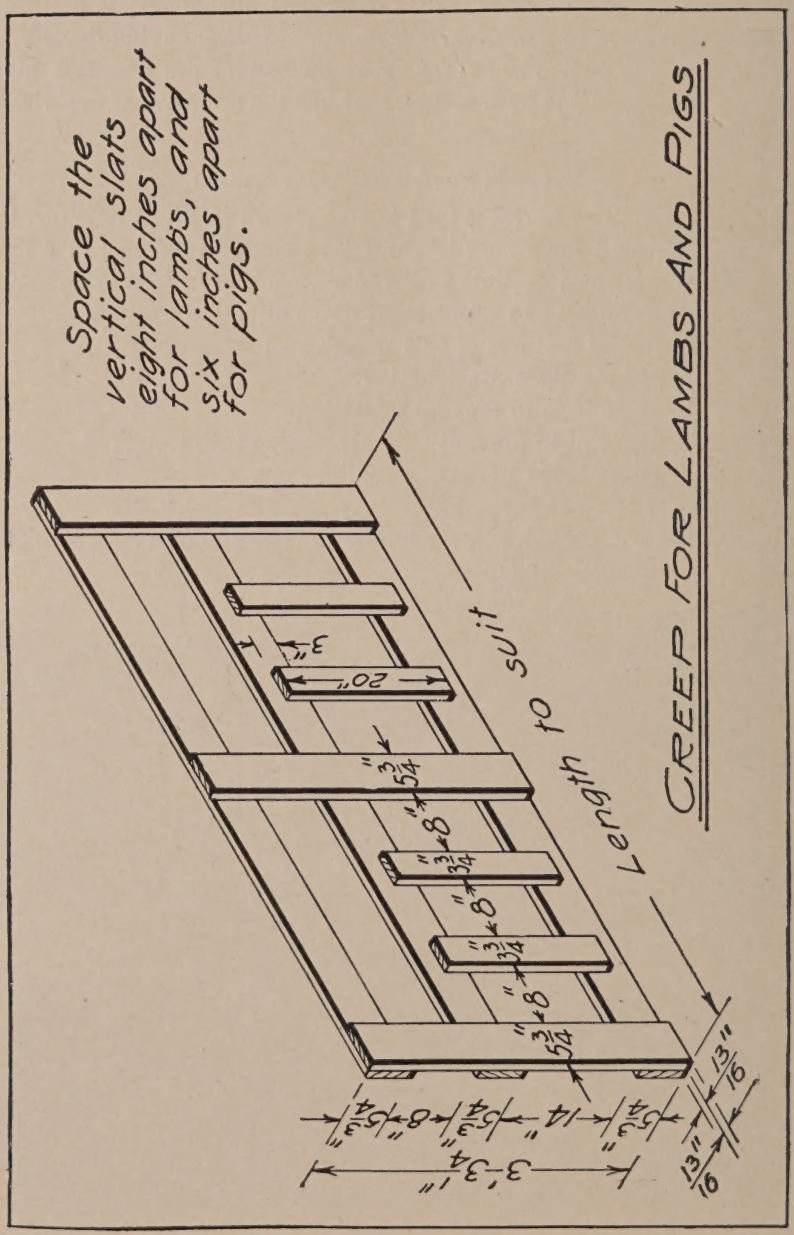


Fig. 144. Creep for Lambs and Pigs

b. *Hardware.*

3 dozen 8d. common wire nails.
1 dozen 8d. finishing nails.
1 dozen 6d. finishing nails.
2 or 3 narrow butt hinges 3″ long with screws.
2 galvanized hooks and screw eyes.

3. *Directions.* The project involves no difficult operation. Care should be taken to make sure that the notch cut in the top of each end is not made wider than the top rail. Use a saw and chisel to make the notches, and fasten the top rail in place with finishing nails or screws.

Creep for Lambs and Pigs

1. *Purpose.* A creep is an enclosure or a part of a fence or partition that has openings through which young stock such as lambs or pigs can readily go, but which excludes the older and larger animals of the same breed. By the use of a creep, young stock may be fed special rations not accessible to the mature animals. Creeps may be built in portable as well as stationary form.
2. *Material required.*

a. *Lumber.* Surfaced lumber is to be preferred.

No. of Pieces	Dimensions	Purpose
3	$\frac{13}{16}$″ × 5¾″ × 6′ 8¼″	Rails
3	$\frac{13}{16}$″ × 5¾″ × 3′ 3¼″	Uprights
4	$\frac{13}{16}$″ × 3¾″ × 1′ 8″	Slats

b. *Hardware.* 5 dozen 8d. common wire nails.

3. *Directions.* Nail the various parts together securely. Clinch all nails well that protrude, and round off corners slightly against which the young animals are likely to rub in going through the openings.

Portable Feed Trough for Sheep

1. *Purpose.* The portable trough shown in Fig. 145 is used in feeding roots and grain rations to sheep. It is similar in design to the one shown for lambs, and is proportionately larger. It is very easy to clean because one side is hinged.
2. *Material required.*

a. *Lumber.* White pine, cypress, western red cedar, etc.

No. of Pieces	Dimensions	Purpose
1	$\frac{13}{16}$″ × 11¾″ × 7′ 10⅜″	Bottom
2	$\frac{13}{16}$″ × 3¾″ × 8′	Sides
2	$\frac{13}{16}$″ × 3¾″ × 2′	Feet
2	$\frac{13}{16}$″ × 1½″ × 11¾″	Cleats
2	$\frac{13}{16}$″ × 11¾″ × 2′ 1½″	Ends
1	1⅛″ × 2″ × 8′	Top Rail

b. *Hardware.*

3 strap hinges with screws.

3 doz. 8d. common wire nails.
1 doz. 8d. finishing nails.
1 doz. 6d. finishing nails.

3. *Directions.*

a. A through mortise is made in the end pieces for the top rail. Use brace and bit and chisel.

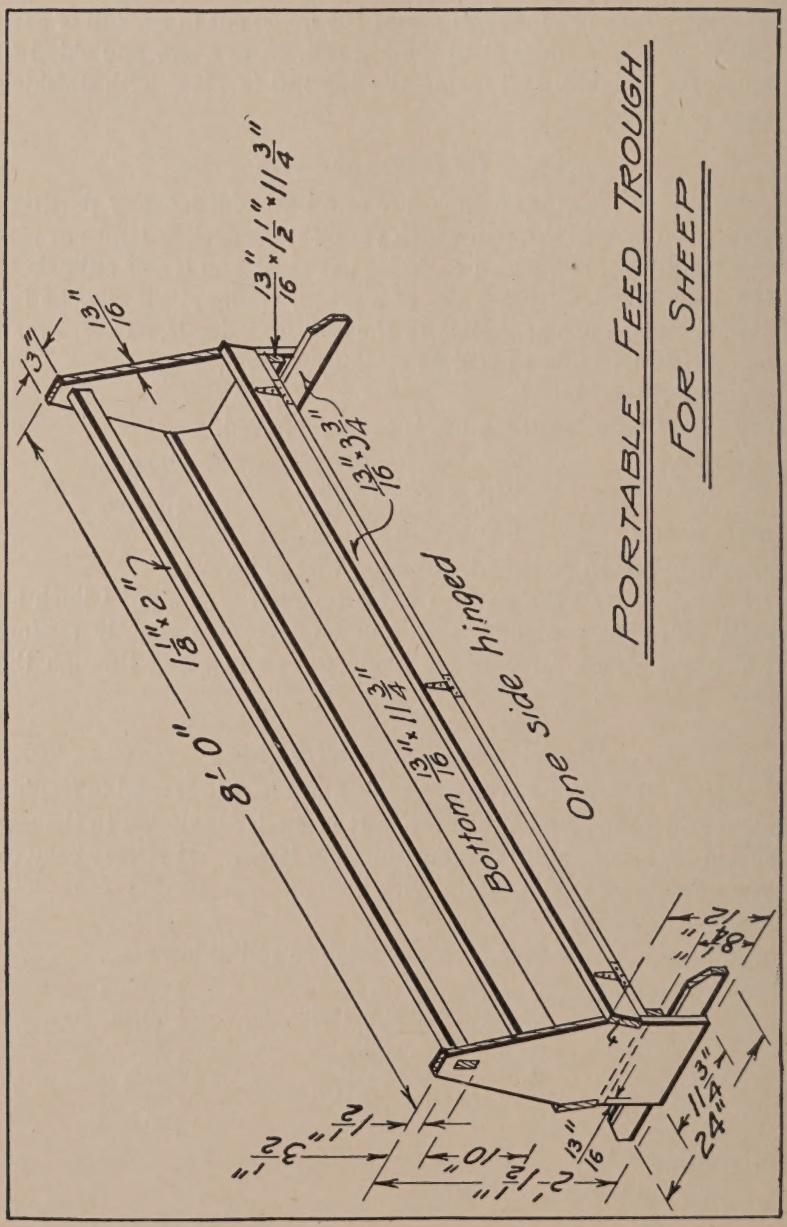


FIG. 145. PORTABLE FEED TROUGH FOR SHEEP

b. The sides are gained in at an angle to the bottom. One side is nailed securely; the other is hinged.
c. The bottom is nailed securely through the end pieces, and into the supporting cleats.
d. Select the top rail with care so that it will not break when used as a handle to carry the trough.

Wool Tying Box

1. *Purpose.* Wool growers and farmers in general, even though they may keep but a small flock of sheep, will be interested in this

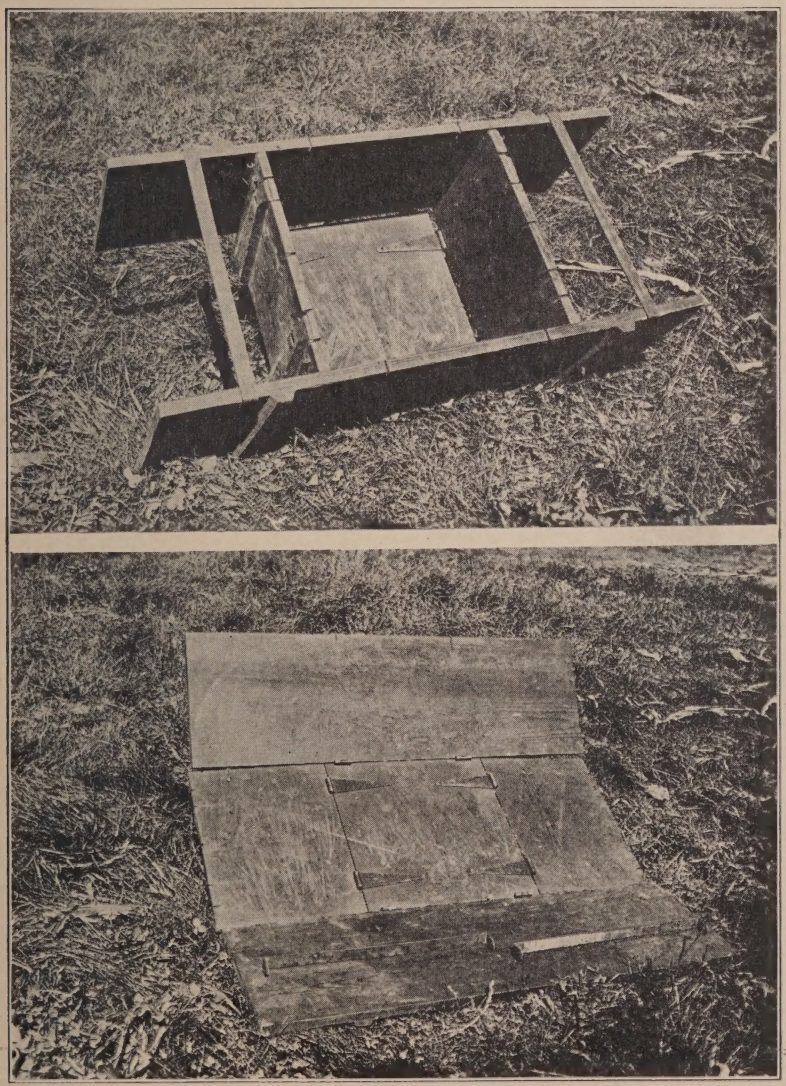


FIG. 146. WOOL TYING BOX IN USE AT THE PENNSYLVANIA STATE COLLEGE

simple labor-saving device. With its aid the fleeces may easily be tied into attractive bundles.

2. *Directions for preparing fleece for tying box.*
   a. Lay the fleece flesh side down on a clean floor.
   b. Turn in the sides of the fleece until the edges meet at the center.
   c. Turn in the neck.

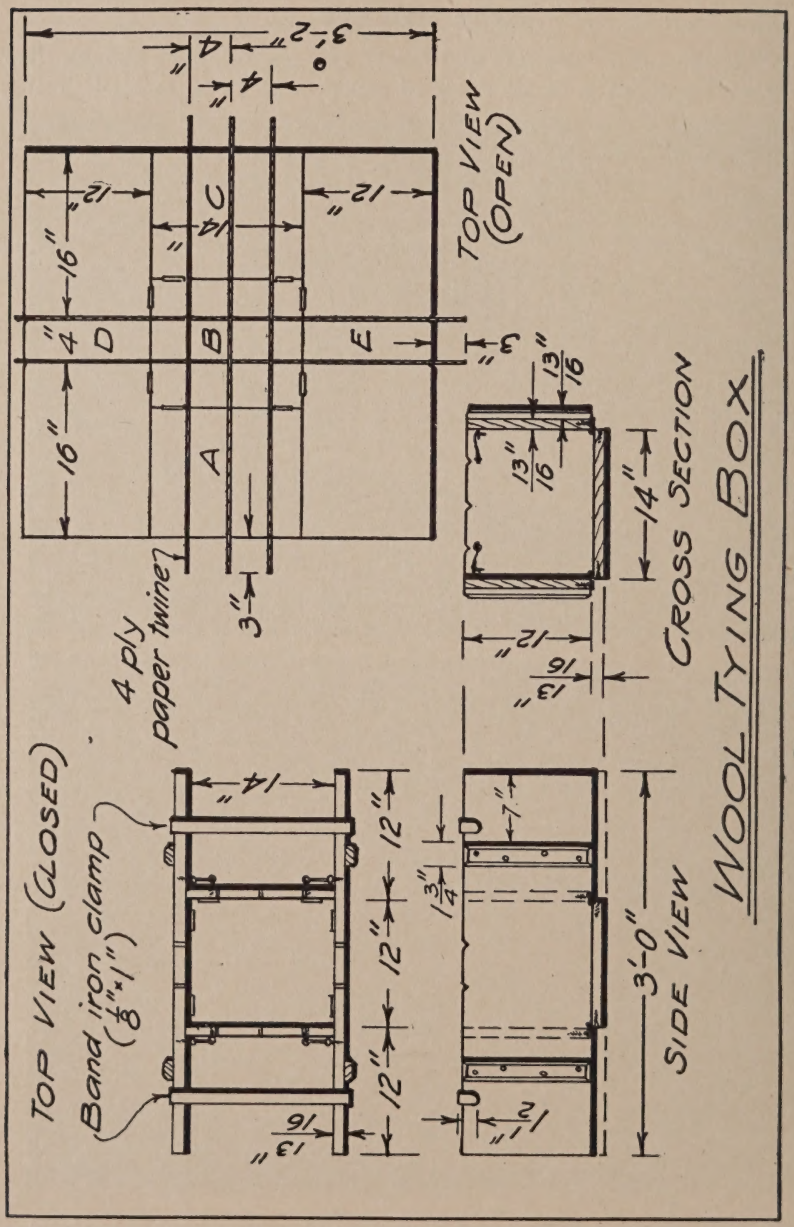


FIG. 147. WOOL TYING BOX

d. Turn in the breech.
e. Fold over once from breech end.
f. Place in wool tying box.

3. *How to use the tying box.*
   a. Place the box on a work bench, table, or other support so that it will be convenient. Lay all the sides down flat, as shown in Fig. 146, and place the twine in position, use 4-ply paper twine, and let the ends extend about 3″ beyond the ends of the extended box.
   b. Bring up the ends "A" and "C" (Fig. 147).
   c. Next bring up the sides "D" and "E."
   d. Use strap-iron clamps to hold sides together (see Fig. 146).
   e. Tie the fleece. Do not tie fine wool too tightly.
4. *Material required.*
   a. *Lumber.* Use a good quality of white pine or similar wood. The box may be made from three boards 12″ wide by 36″ long, and one board 14″ wide by 36″ long.

No. of Pieces	Dimensions	Purpose
2	$^{13}/_{16}$″ × 12″ × 3′	Sides
2	$^{13}/_{16}$″ × 12″ × 14″	Ends
1	$^{13}/_{16}$″ × 12″ × 14″	Bottom
4	$^{13}/_{16}$″ × 1¾″ × 12″	Cleats

   b. *Hardware.*
      8 pairs of narrow butt hinges 3″ long (brass preferred) with screws.
      4 galvanized hooks and screw-eyes.
      2 pieces ⅛″ × 1″ × 17″ band iron.
      6 1¼″ No. 8 screws, flat-head, bright.

Fig. 148. Mr. W. B. Connell of the Pennsylvania State College, giving a Shearing Demonstration in Indiana County, Pa.
Photograph, courtesy of Mr. J. W. Warner, County Agent, Indiana County.

5. *Directions for making box.*
   a. Various types of hinges may be used. Fig. 146 shows strap hinges; these are strong and easy to apply, but are objected to by some because the wool will catch on them if they are at all loose.
   b. All wood and metal parts should be smooth.
   c. Chamfer the cleats and fasten them to sides with screws.

Portable Hay and Grain Rack for Sheep

1. *Purpose.* Small lots of sheep are fed conveniently and satisfactorily from combination hay and grain racks. These racks are of two principal kinds; the portable kind shown herewith, and stationary type shown later that is built fast to the sides of the sheep barn.

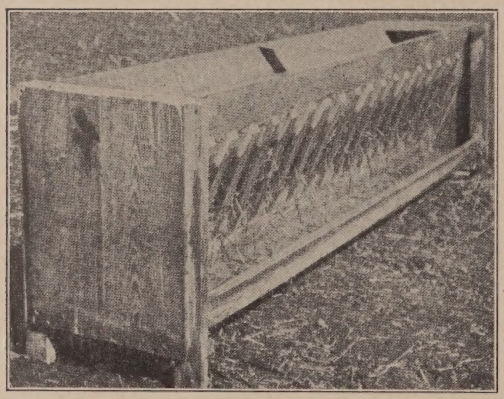


FIG. 149. PORTABLE HAY AND GRAIN RACK FOR SHEEP
Built and used by the Pennsylvania State College.

Special features of this rack are the wide boards at the top of the rack, which keep chaff from getting into the fleeces, and the hinged sides of the grain troughs which facilitate cleaning.

2. *Material required.*
   a. *Lumber.* Yellow pine, or other inexpensive lumber may be used. Planed lumber should be used. For a rack 10′ long the following is required:

No. of Pieces	Dimensions	Purpose
36	13/16″ × 2¾″ × 24″	Slats
4	1¾″ × 3¾″ × 3′ 2″	Legs
4	13/16″ × 11¾″ × 3′ 2″	End boards
4	1¾″ × 3¾″ × 2′ 4″	Cross-ties
1	13/16″ × 3¾″ × 1′ 10″	Cross-ties
2	13/16″ × 11¾″ × 9′ 10⅜″	Sides
1	1¾″ × 5½″ × 9′ 10⅜″	Division board
1	1¾″ × 3¾″ × 9′ 10⅜″	Division cap
2	13/16″ × 9¾″ × 9′ 10⅜″	Bottom of feed trough
2	13/16″ × 5¾″ × 9′ 6⅞″	Sides of feed trough

   b. *Hardware.*
      6 6″ strap hinges with screws.
      1 lb. 6d. common wire nails.
      1 lb. 8d. common wire nails.
      1 lb. 16d. common wire nails.
      1 lb. 8d. finishing nails.
      4 galvanized hooks and screw-eyes.

3. *Directions.*
   a. Assemble the framework of the ends first.
   b. Nail the division plank in place and the wide boards at the top of the sides.
   c. Next put in place the bottom boards to the feed trough.
   d. Complete the construction using 6d. nails for the slats, and 16d.

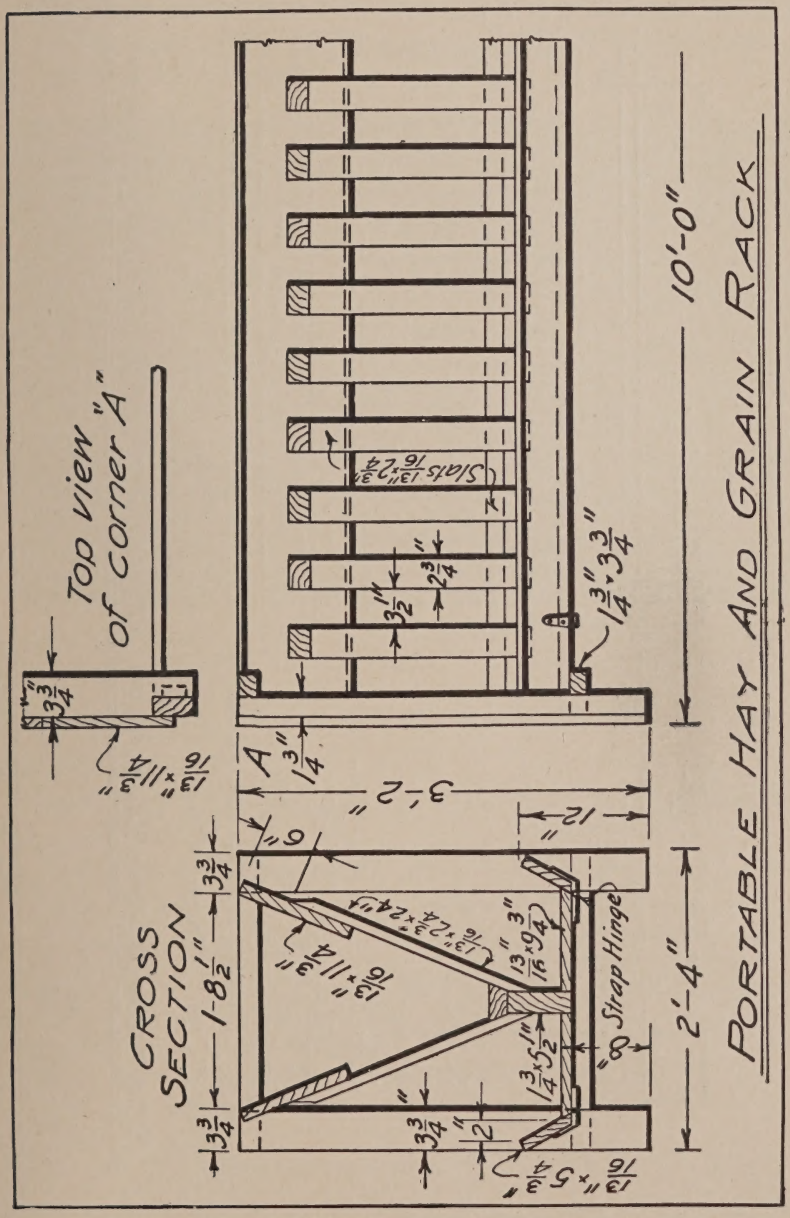


FIG. 150. PORTABLE HAY AND GRAIN RACK

spikes when 2″ material is nailed to 2″ material. Use finishing nails where common nails would tend to split the lumber.

e. Round off slightly all edges against which the sheep are likely to rub in the feeding process.

f. Adapt the construction to your needs and to the material available. Keep the top of the grain trough about 12″ from the floor.

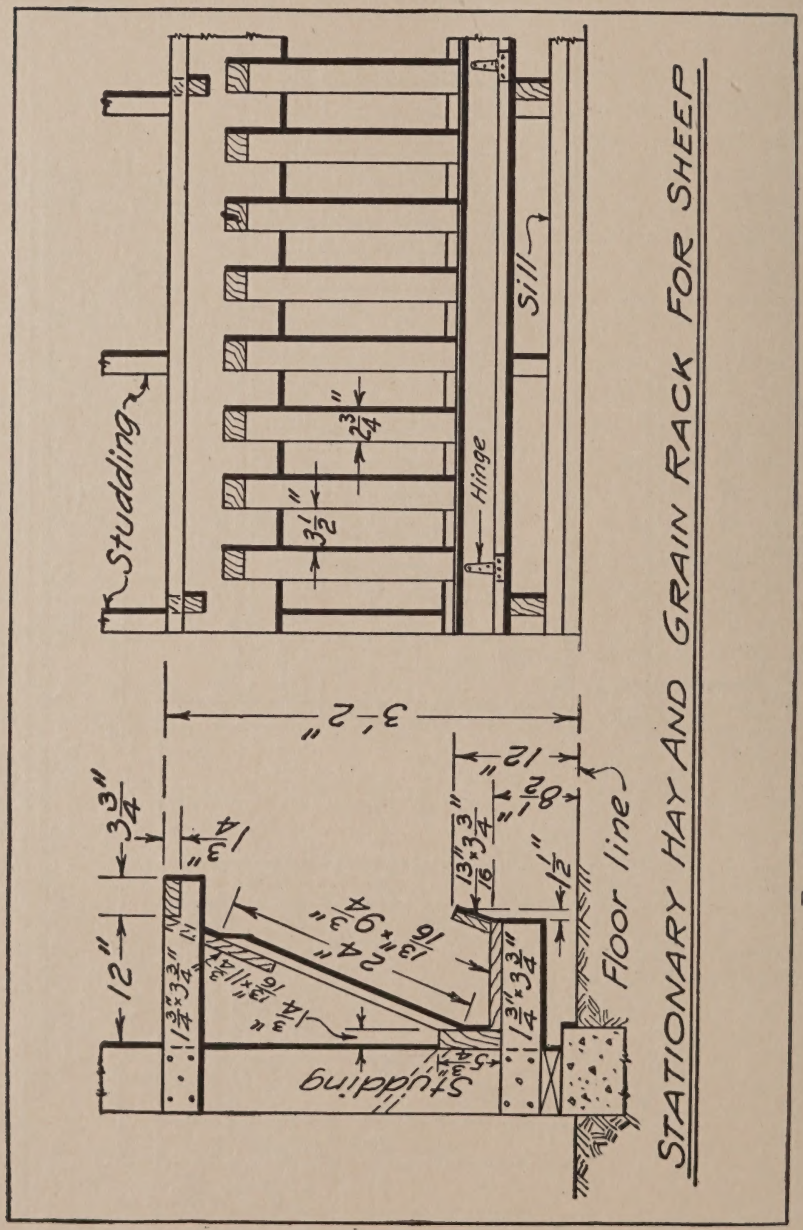


FIG. 151. STATIONARY HAY AND GRAIN RACK FOR SHEEP

Stationary Hay and Grain Rack

1. *Purpose.* The stationary hay and grain rack shown in Fig. 151 may be built directly against the walls of the barn or against feed-pen partitions. It thus saves considerable floor space. The size of the floor and other considerations will govern the location and the length of such feed racks.

Instead of the hinged side of the feed trough some persons prefer to have this side nailed fast and to use separate feed trays that are placed into the trough.

FIG. 152. SHEEP DIPPING DEMONSTRATION PUT ON IN INDIANA COUNTY, PA., BY J. W. WARNER, COUNTY AGENT, SHOWING SHEET-IRON DIPPING VAT AND THE DRAINING PEN

The sheep were dipped at the rate of one per minute. Photograph by J. W. Warner.

2. *Material required.*

a. *Lumber.* The requirements are the same as for the preceding project.

The following is required for a 10′ length:

No. of Pieces	Dimensions	Purpose
4	1¾″ × 3¾″ × 16″	Supports for trough
1	1¾″ × 5¾″ × 10′	Back for trough
1	13/16″ × 9¾″ × 10′	Bottom for trough
1	13/16″ × 3¾″ × 10′	Front for trough
3	1¾″ × 3¾″ × 20½″	Top cross-ties
1	1¾″ × 3¾″ × 10′	Top rail
1	13/16″ × 11¾″ × 10′	Top board
18	13/16″ × 2¾″ × 24″	Slats

b. *Hardware.*

3 "T" hinges with screws.

½ lb. 6d. common wire nails.

1 lb. 8d. common wire nails.
1 lb. 16d. common wire nails.
½ lb. 8d. finishing nails.
2 galvanized hooks and screw-eyes.

3. *Directions.*

a. The construction should be kept standard as regards the major

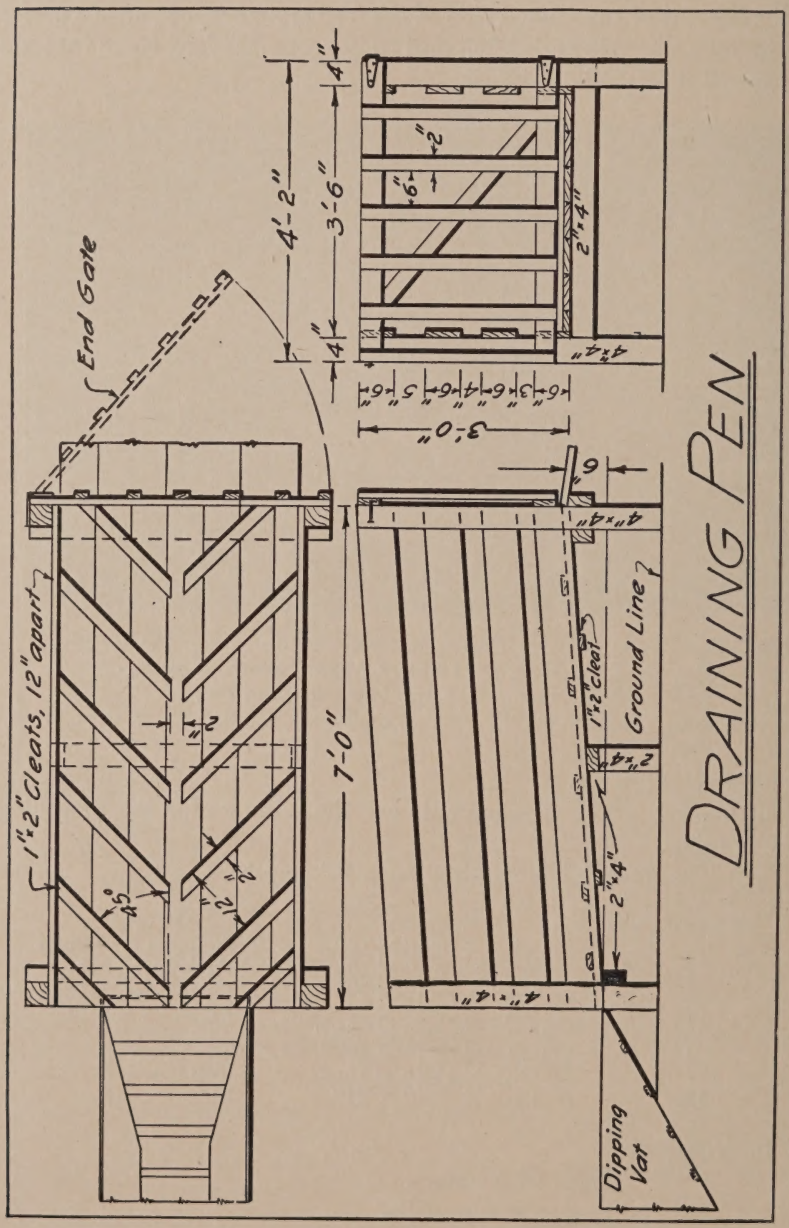


FIG. 153. DRAINING PEN

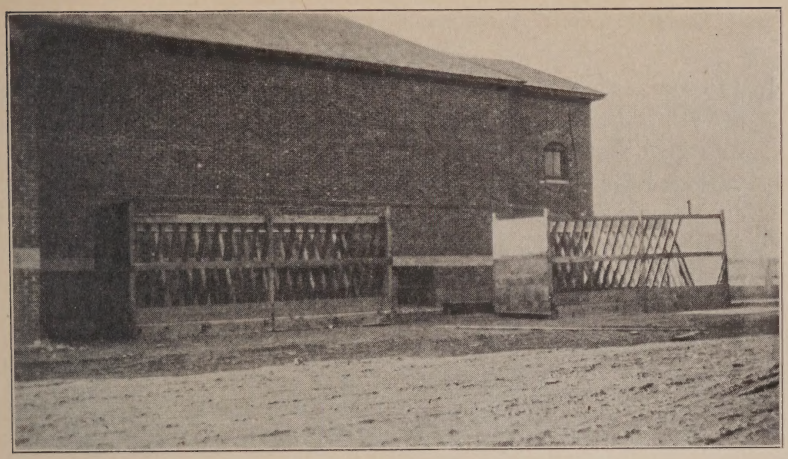


FIG. 154. A WESTERN TYPE OF FEED RACK FOR SHEEP

Built by pupils at the Parma, Idaho, High School, Mr. A. W. Watts, instructor. Photograph, courtesy of Mr. George E. Denman, State Supervisor of Agricultural Education, Boise, Idaho.

proportions such as the size of the feed trough, and its height from the ground or floor. In adapting the design to various side-walls or partitions the lengths of the cross-ties will naturally vary, and the over-all length will be variable.

b. The general method of construction is much the same as in the preceding project, and presents no difficulties of construction.

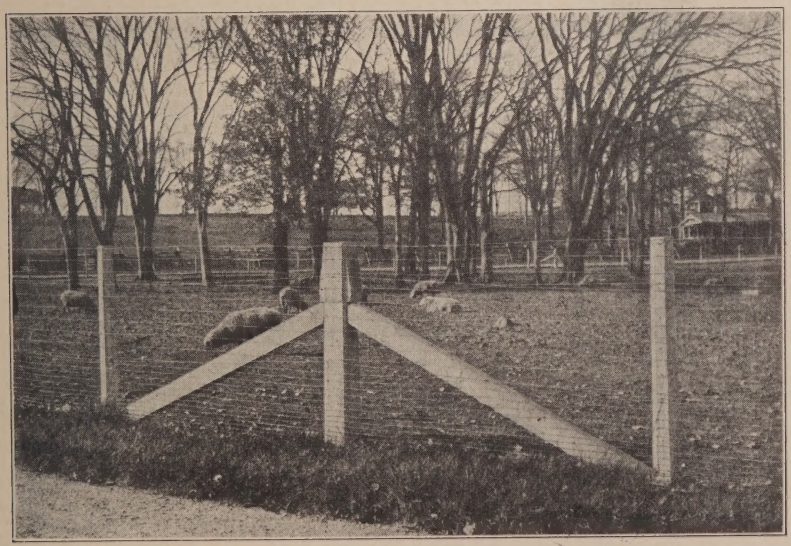


FIG. 155. CONCRETE FENCE POSTS NEAR GENEVA, ILL.

Note anchor posts and braces as used in long lines of fencing. Photograph, courtesy Portland Cement Association.

Draining Pen

1. *Purpose.* Since ticks and other skin parasites annoy and retard the growth of lambs and sheep, it is desirable to dip them in standard solutions that will rid the animals of the pests. For this purpose various forms of dipping troughs are used, some being built out of concrete. For the small flock it is cheaper to buy a sheet-metal dipping vat such as is shown in Fig. 152, than it is to build a permanent concrete vat. Draining pens are a necessary accessory to a

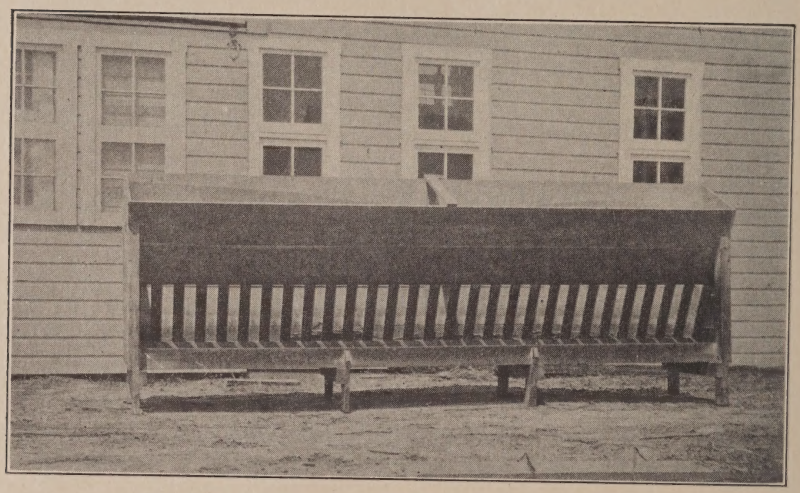


FIG. 156. PORTABLE FEEDING RACK FOR SHEEP

Used by the Ohio State Experiment Station, Wooster, Ohio. Photograph, courtesy of Mr. J. W. Hammond, Associate in Wool Investigations.

dipping vat. The draining pen shown herewith is designed to hold about four sheep at one time. The purpose of the draining pen is to save the dipping solution by making it flow back into the vat.

No matter what solution is used it is advisable to shade the draining pen during hot weather. A shorn sheep will readily sunburn if wet with pure water and allowed to stand in the hot sun. Therefore, precaution needs to be taken with solutions containing insect destroying ingredients. Sheep likewise should not be allowed to go in the rain immediately after being dipped as heavy rains would wash the dip out of the fleece before it has dried and become set.

2. *Material required.*

a. *Lumber.*

No. of Pieces	Dimensions	Purpose
6	4″ × 4″ × 6 to 8′ long	Posts
2	2″ × 4″ × 1′	Supports
4	2″ × 4″ × 4′ 2″	Cross-ties
6	1″ × 6″ × 7′	Side boards

No. of Pieces	Dimensions	Purpose
24 lineal ft.	1″ × 2″	End gate
24 lineal ft.	1″ × 2″	Floor cleats
2	1″ × 4″ × 4′ 2″	End gate
2	1″ × 2″ × 3′ 6″	Bottom cleats
27 sq. ft.	13/16″ × 4″ or 6″ matched flooring	Floor

b. *Hardware.*

2 lb. 6d. common wire nails.
1 lb. 8d. common wire nails.
1 lb. 16d. common wire nails.
2 8″ strap hinges with screws.
1 hook and screw-eye.

2. *Directions.*

a. Give the floor a pitch of about 6″ in 7′.

b. The flooring should be laid tight, and should be free of knots. It may be nailed to cleats and only tacked to the 2″ × 4″ cross-ties, thus making it possible to take it up in one section for storage.

c. One man standing at the low point of the pen where it meets the dipping vat, can control both ends of the pen by using a pole which is fastened to the end gate in such a way that pulling on it closes, and pushing opens the end gate.

d. The pickets or slats on the end gate may be fastened on with 6d. nails. The floor likewise can be nailed with 6d. common wire nails.

e. A run-way of varying length may need to be built from the high end of the draining pen to the ground.

REFERENCES

1. *Free bulletins and circulars.*

Equipment for Farm Sheep Raising. McWhorter, V. O. Farmers' Bulletin 810.

Fattening Lambs. Withycombe, Robert, and Potter, E. L. Bulletin 175, 1920, Oregon Agricultural College.

Fattening Lambs. Jones, J. M. Bulletin 186, 1916, Agricultural Experiment Station, College Station, Texas.

Fattening Range Lambs. Carmichael, B. E. Bulletin No. 187, 1907, Agricultural Experiment Station, Wooster, Ohio.

Green Forage Crops and Corn for Fattening Lambs. Hammond, J. W. Bulletin No. 340, 1920, Agricultural Experiment Station, Wooster, Ohio.

Lambing Sheds. Miller, R. F., and Fermery, J. E. Circular No. 188, 1917. Agricultural Experiment Station, Berkeley, California.

Sheep Raising. Severson, B. O. Extension Circular No. 49, 1916. Pennsylvania State College, State College, Pa.

2. *Text and reference books.*

Coffey, Walter C. *Productive Sheep Husbandry.* J. B. Lippincott Co.

Kleinheinz, Frank. *Sheep Management.* Privately published.

CHAPTER XII

RELATING TO HORSE HUSBANDRY

THE projects given under the above heading deal with the care of the horse and harness, but not with accessories such as singletrees, doubletrees, and wagon racks. The latter are shown elsewhere in this book.

Harness Hooks

1. *Purpose.* Simple and substantial hooks for harness may be made as shown in Fig. 157. The length of the plank into which the pegs or hooks are driven may be varied to suit given requirements, as may also the distance between hooks. The purpose of the drawing is to bring out the principle of construction. Its adaptation to local requirements is not attempted by the author.
2. *Material required.*
   a. *Lumber.* Soft wood, such as yellow pine or fir, for the plank, and hard wood, such as oak or maple, for the pegs.

No. of Pieces	Dimensions	Purpose
1	$2\frac{3}{4}'' \times 9\frac{3}{4}'' \times 9'$	Plank
3	$8'' \times 2\frac{5}{16}'' \times 15''$	Large hooks
2	$\frac{7}{8}''$ diameter $\times 10''$	Small hooks

   b. *Glue.* A small quantity of liquid glue.
3. *Directions.*
   a. The small pegs are intended for the bridle or accessories; the remainder of the harness may be hung on the large pegs.
   b. A convenient way to make the smaller pegs is by using pieces of an old broom, hoe, or pitchfork handle. Saw a kerf into one end, make a white pine wedge and drive it into place after a little glue has been applied.
   c. If the peg is to be driven into a timber, the wedge is placed in the kerf before the peg is driven in. It will tighten up as it comes in contact with the bottom of the hole.
   d. The large pegs can be split out of larger sticks, and may be shaped to suit. They are fastened the same way as the smaller ones.
   e. Select pegs with straight grain, and place them so that the grain is vertical, or nearly so.

Harness Hook

1. *Purpose.* Another type of harness hook is shown in Fig. 158. This hook likewise is substantial and can be adapted to various positions and kinds of lumber available. It may, for example, be built directly on posts or studdings that stand in the barn.

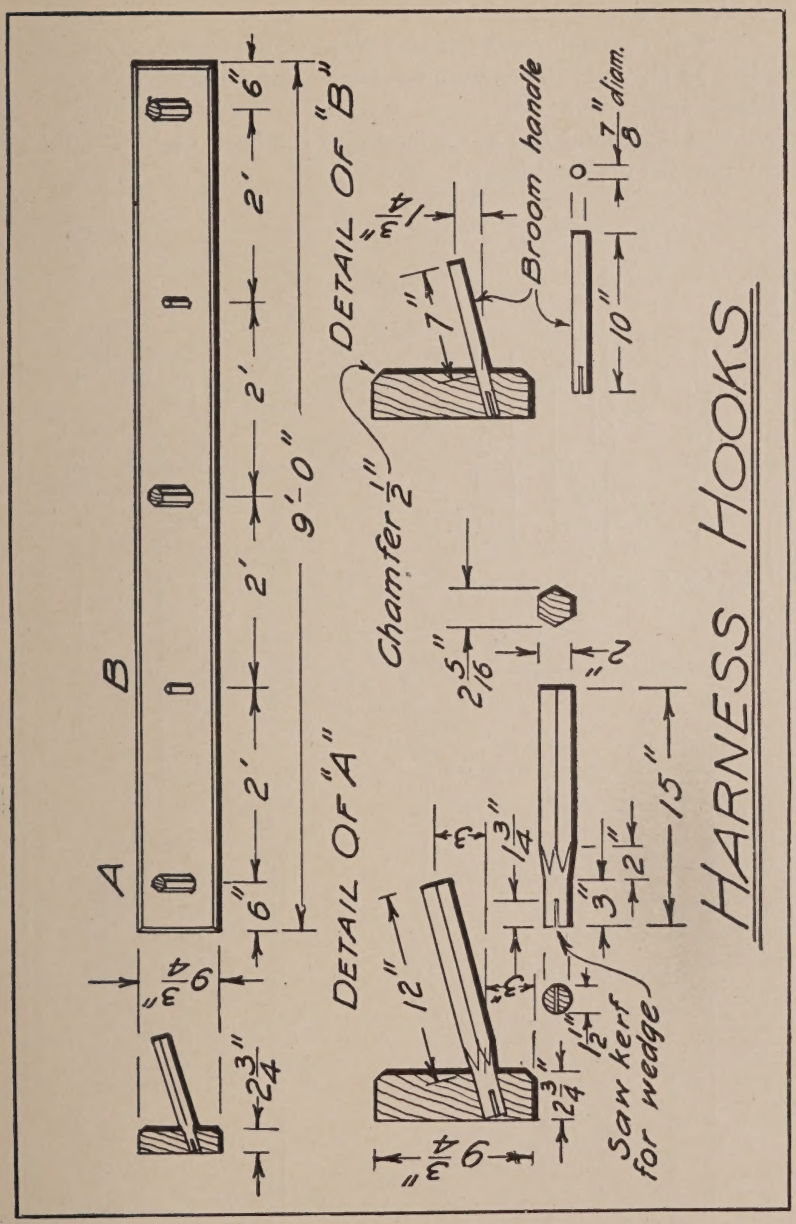


FIG. 157. HARNESS HOOKS

2. *Material required.*

a. *Lumber.* White pine, or other soft woods.

NO. OF PIECES	DIMENSIONS	PURPOSE
1	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 18''$	Back
1	$1\frac{3}{16}'' \times 3\frac{1}{4}'' \times 17\frac{1}{2}''$	Diagonal strut
2	$1\frac{3}{16}'' \times 2\frac{3}{4}'' \times 12''$	Horizontal ties

b. *Hardware.*

4 3″ common screws or else ¼″ × 3″ lag screws.

15 1¼″ No. 10 common flat head bright screws.

3. *Directions.*

a. The horizontal ties are gained into the back piece ¼″, but not into the diagonal brace.

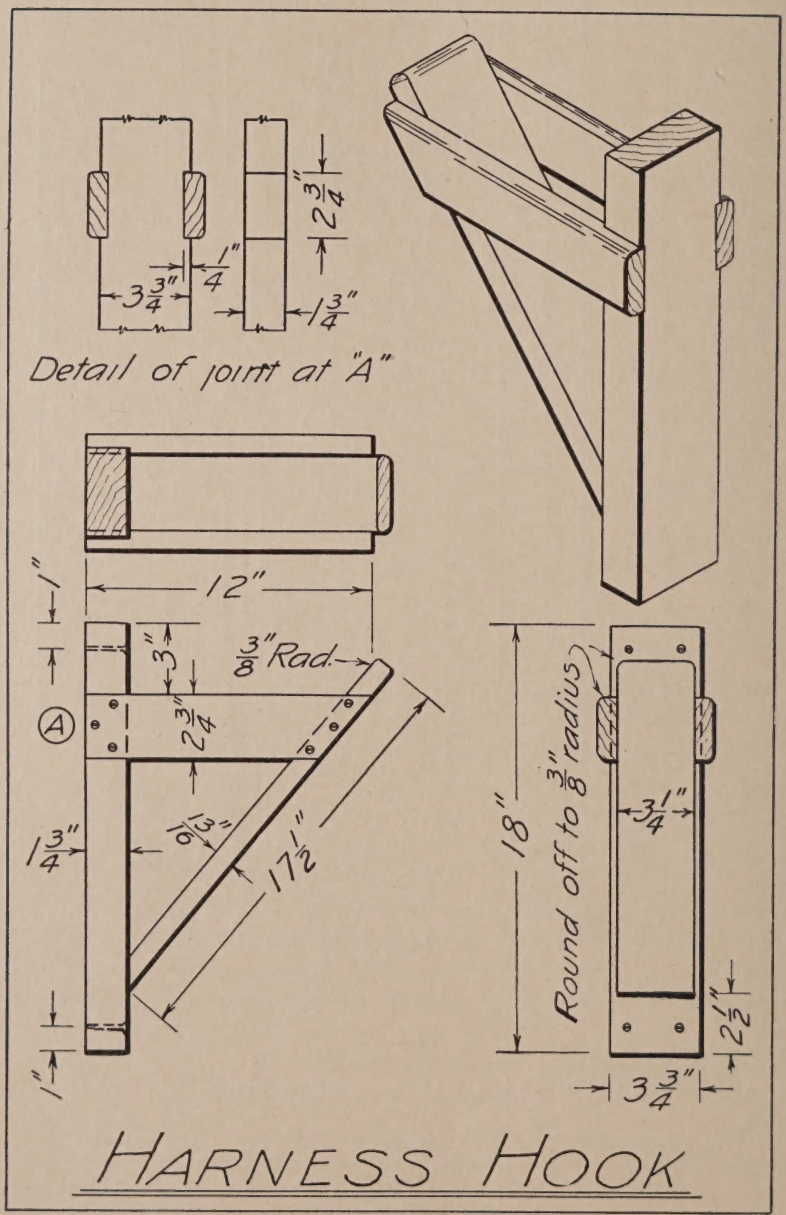


FIG. 158. HARNESS HOOK

b. Round off the outside edges of the horizontal ties.

c. Finish with several coats of linseed oil.

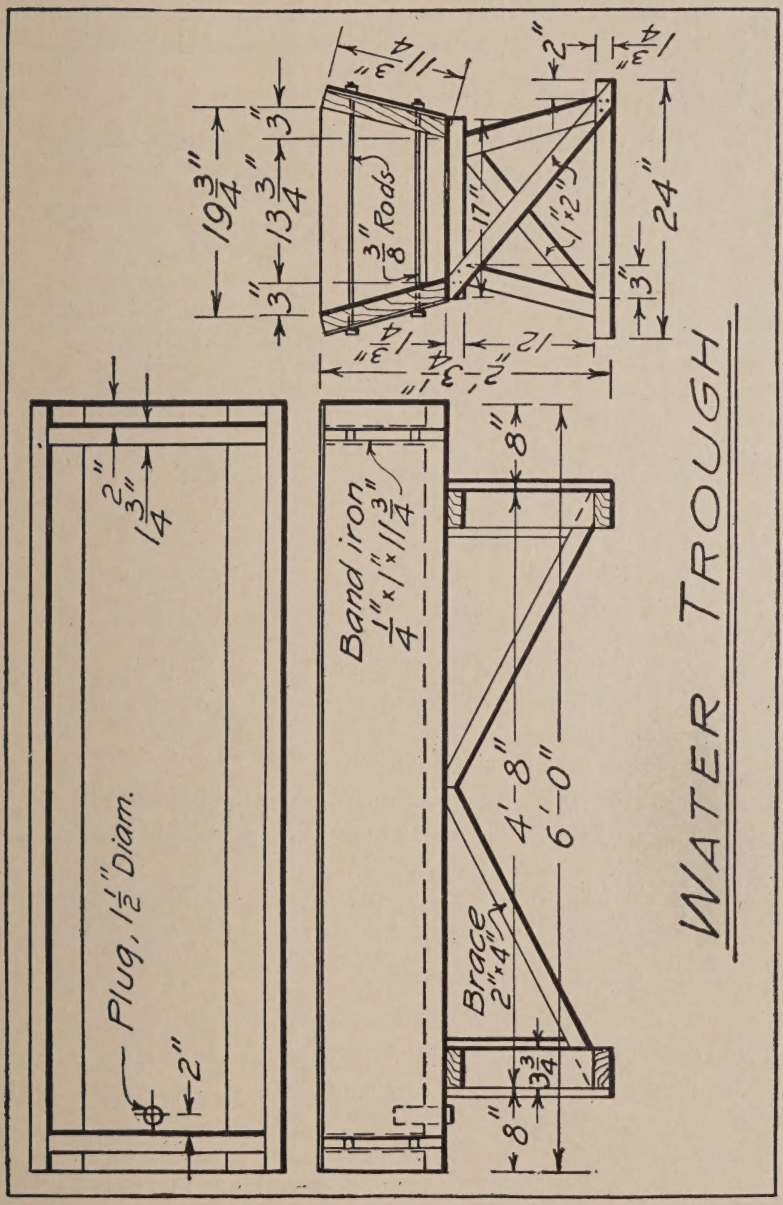


FIG. 159. WATER TROUGH.

Water Trough

1. *Purpose.* Water troughs, such as the one shown in Fig. 159, are extensively used for horses and other farm animals, such as dairy and beef cattle.

The trough is made with splayed sides. One advantage of thus

spreading the sides is that when ice forms it will push upward instead of outward, and thereby save the trough from breaking.

The trough should have a slope lengthwise of about ¼″ per foot of length, so that it will drain readily through the hole provided for the purpose.

2. *Material required.*

a. *Lumber.* Cypress, western red cedar, red wood, chestnut oak, and other woods may be used to advantage.

No. of Pieces	Dimensions	Purpose
1	1¾″ × 13¾″ × 6′	Bottom
2	1¾″ × 11¾″ × 6′	Sides
2	1¾″ × 11¾″ × 19¾″	Ends
2	1¾″ × 3¾″ × 24″	Lower plate
2	1¾″ × 3¾″ × 17″	Upper plates
4	1¾″ × 3¾″ × 12 7/16″	Legs
2	1¾″ × 3¾″ × 2′ 8″	Braces
4	13/16″ × 1¾″ × 2′ 2″	Braces
1	1¾″ round plug tapering to 1½″, 6″ long.	

b. *Hardware.*

4 pieces ¼″ × 1″ × 11¾″ band iron or steel.
2 ⅜″ × 1′ 9″ rod with nut.
2 ⅜″ × 23½″ rod with nut.
½ lb. 8d. common wire nails.
2 lb. 20d. common wire nails.

3. *Directions.*

a. The correct level and the length of the legs for the bents may be found by using 3″ on the tongue and 12″ on the blade of the framing square.

b. The joints are all plain butt joints.

c. Place 20d. spikes about 4″ apart when nailing the sides to the bottom. Stagger the nails a little to prevent them from splitting the sides.

d. It is well to provide an overflow either in the form of a hole with a small piece of pipe screwed into it, or in the form of a standard waste pipe connection.

Manger and Stall for Horse Stable

1. *Purpose.* Horses are usually kept in stables having some form of partition and a manger at one end. The one shown in Fig. 160 shows proper proportions and typical construction.

2. *General proportions.*

a. *Length.* Horse stalls of the type shown should be about 10′ long from the back of the manger (as the horse faces it) to the end of the partition.

b. *Width.* From 5′ to 6′ center to center of partitions gives space enough.

c. *Pitch of floor.* The floor should have a fall of ¼″ per foot of

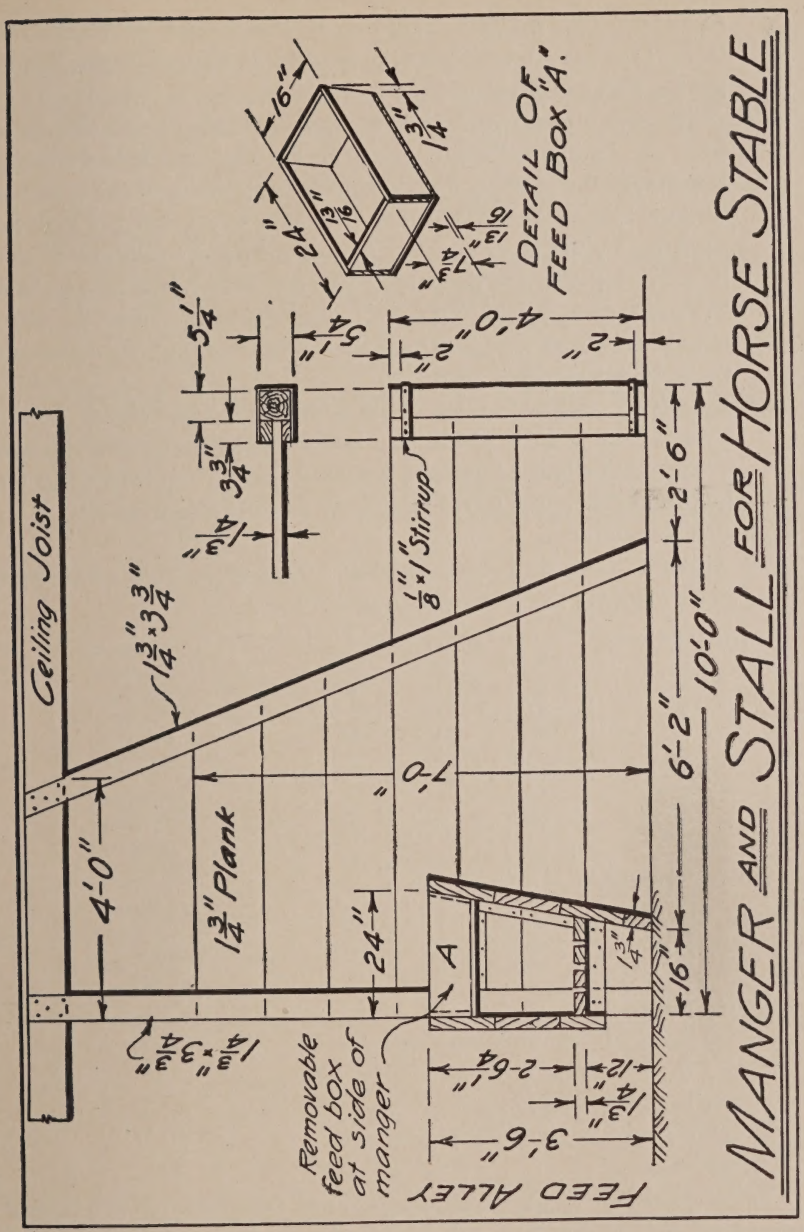


FIG. 160. MANGER AND STALL FOR HORSE STABLE

length. It is quite common to give too much fall to floors in stalls.

d. *Manger.* The bottom of the manger should be from 12″ to 16″ above the floor. It is well to have the bottom of the manger built of slats ¾″ or 1″ apart so that dust, dirt, and disease germs do not accumulate.

Place a feed box at one end of the manger, and make it re-

movable. The manger should be 3′ 6″ high and 24″ wide at the top. It is best to board up the manger so that the horse cannot get his feet caught under the manger.

e. *Partitions.* These vary from a simple swinging beam supported from the ceiling to "solid" partitions. The nature of the partitions desired will depend upon the characteristics of the horses to be kept there. For horses that are likely to rear up and kick the partition should be such as will permit the horse to slide off in case he gets a leg over the partition. For this reason it is best to have the end post of the partition no higher than the planking. Slats may be run from the planking to the ceiling so that horses cannot possibly get astride a partition.

f. *Box stalls.* Should be 10′ × 12′ or larger. They should not be boarded up solid. Stallions, brood-mares, or other animals should not be imprisoned in a box stall that resembles a dungeon, but should be quartered where they can see other animals.

3. *Material required.*

a. *Lumber.* The stall shown in Fig. 160 may be built of Georgia pine, Douglas fir, or other lumber.

No. of Pieces	Dimensions	Purpose
4	1¾″ × 11¾″ × 10′	Partition
1	1¾″ × 11¾″ × 6′	Partition
1	1¾″ × 11¾″ × 5′ 6″	Partition
1	1¾″ × 11¾″ × 5′	Partition
2	1¾″ × 3¾″ × 10′ (depends on ceiling height)	Partition
2	1¾″ × 3¾″ × 4′	Partition
1	5¼″ × 5¾″ × 4′	Partition
6	1¾″ × 11¾″ × 6′	Manger
4	1¾″ × 2¾″ × 6′	Manger
8 lineal feet	13/16″ × 1¾″	Manger
2	1¾″ × 3¾″ × 16″	Manger
2	13/16″ × 7¾″ × 24″	Feed box
2	13/16″ × 7¾″ × 14¾″	Feed box
2	13/16″ × 8″ × 24″	Feed box

b. *Hardware.*

2 lbs. 16d. common wire nails.
1 lb. 8d. common wire nails.
1 lb. 8d. finishing nails.
2 pcs. ⅛″ × 1″ × 23¼″ band iron.

4. *Directions.*

a. Note the slatted bottom in the manger, and the provision in feed alley for gathering up particles that drop through the manger.

b. Use surfaced lumber throughout, and round off all corners where horses are likely to rub.

c. A piece of band iron may be nailed along the top of the manger to keep it from being chewed.

d. Allow at least 4 feet behind the stalls for a passageway.

e. If a gutter is built it should be shallow. It is not essential.

f. A dirt floor is commonly used in horse barns, though a plank floor or a concrete floor is usually preferred.

g. Horses do not need as much protection against cold weather as do dairy cows, so horse barns are frequently built of only one thickness of lumber.

REFERENCES

1. *Free bulletins and circulars.*
College Farm Buildings. Shaw, R. S., and Jeffery, J. A. Bulletin 250, 1907, Michigan Agricultural College, Lansing, Michigan.
Farm Buildings. Lewis, Frank C. Circular No. 100, 1921. Purdue University Agricultural Experiment Station, Lafayette, Ind.
Feeding Alfalfa to Horses. Gramlich, H. J. Extension Bulletin No. 28, Agricultural Experiment Station, Lincoln, Nebraska.
Practical Horse Breeding. Harper, M. W. The Horse Series, Bulletin No. 3, Cornell Reading Course, School of Agriculture, Cornell University, Ithaca, N.Y.
2. *Text or reference books.*
Gay, Carl W. *Productive Horse Husbandry.* J. B. Lippincott Co.
Plumb, C. S. *Beginnings in Animal Husbandry.* Webb Publishing Co.
Tormey, John L., and Lawry, Rolla C. *Animal Husbandry.* American Book Co.

CHAPTER XIII

RELATING TO DAIRY HUSBANDRY

It has been said that "the dairy cow is the foster-mother of the human race." The projects given in this chapter have been selected with a view toward being of service to dairymen and farmers in general who keep dairy stock. Space is given, among other things, to stanchion and feed rack construction because improvements of this kind can often be

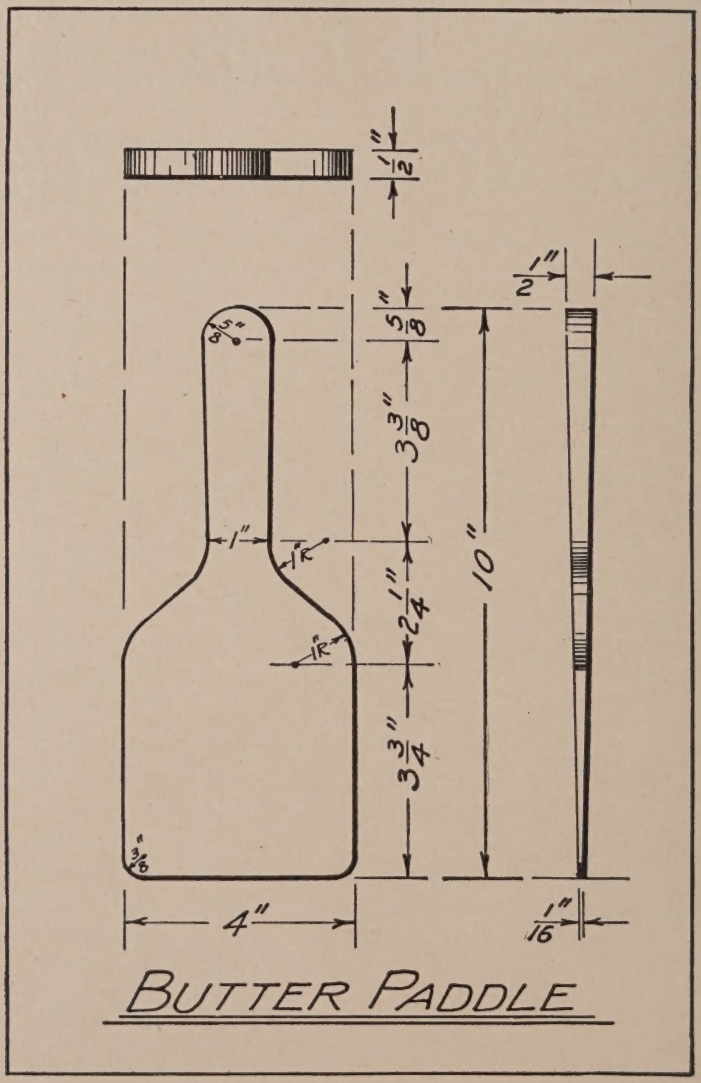


Fig. 161. Butter Paddle

made to advantage in the older types of barns frequently found, as well as in new farm structures.

Butter Paddle

1. *Purpose.* A simple and yet very useful article on almost all farms is a butter paddle, such as is used in working and handling butter. Various sizes and styles are in common use. The one shown herewith is typical, and satisfactory.
2. *Material required.*
   a. *Lumber.* Non-resinous wood should be used, such as maple, beech, or tideland spruce.

No. of Pieces	Dimensions	Purpose
1	½″ × 4″ × 10″	Paddle

3. *Directions.*
   a. Lay out the pattern on the piece of wood.
   b. Saw close to the lines, but leave them visible.
   c. Taper the paddle to the required thickness, by first roughing off the piece with a draw-knife, chisel, or spoke-shave followed by a smooth-plane or jointer.
   d. No oil or paint should be applied.

Milking Stool (No. 1)

1. *Purpose.* The stool shown herewith is a favorite. It is light, easy to keep clean, and difficult to upset. At the same time it is small enough so that the milk pail can easily be withdrawn in case the cow starts to kick.
2. *Material required.*
   a. *Lumber.* Hard wood, such as maple or oak, is best. The legs may be made of old broom or hoe handles.

No. of Pieces	Dimensions	Purpose
3	⅞″ round × 10″ long	Legs
2	$^{13}/_{16}$″ × 9″ diameter	Top

   b. *Hardware.* 1 doz. 1¼″ No. 8 flat head bright screws.
   c. *Paint.* A small amount of white paint.
3. *Directions.*
   a. While the top may be made of two separate boards, one placed crosswise of the other, and screwed together in a secure manner, the top may also be made of one piece of plank 1¾″ thick.
   b. The legs may be made of broom handles, of squared stock, or of pieces split out of a larger block in which case they may be worked into six-sided shapes, with the use of a draw-knife and plane.
   c. Note that each leg has a saw-kerf at its top for the wedge which is inserted before the leg is driven into place.
   d. Use a little glue on the legs where they fit into the top.
   e. Paint or enamel the stool white.

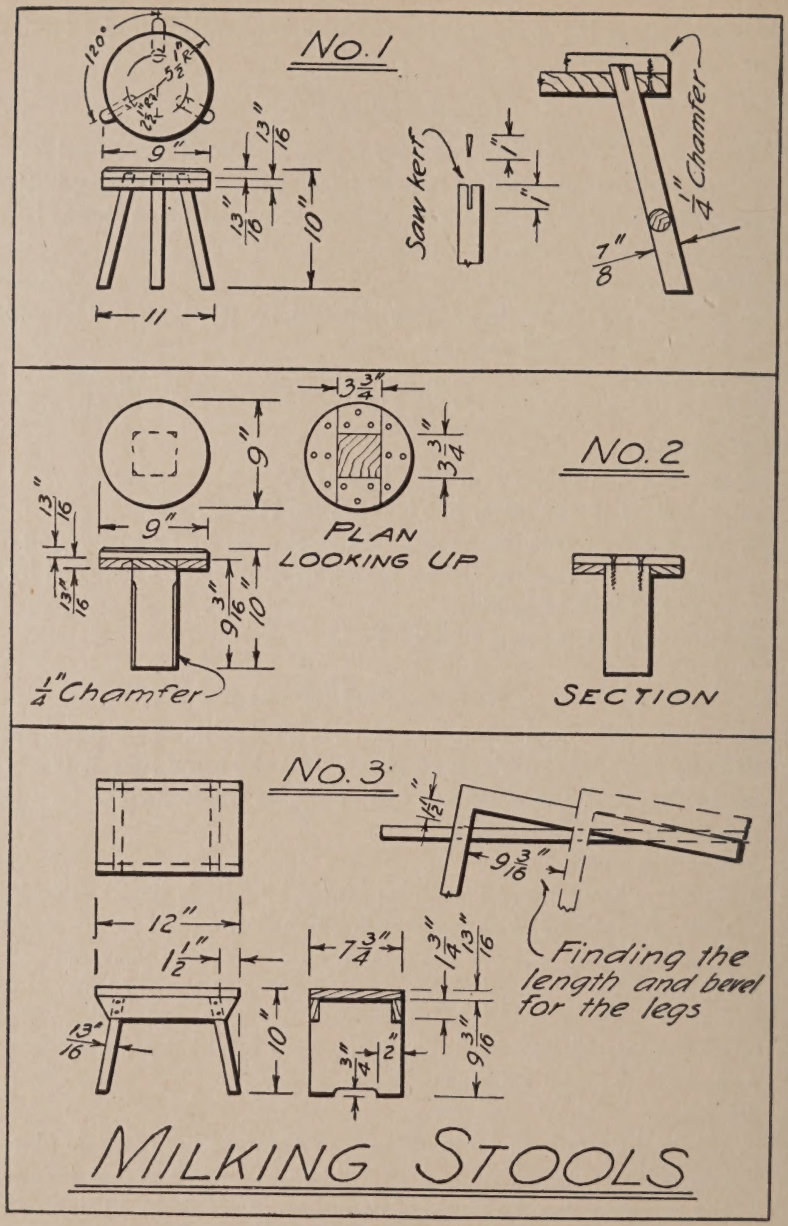


FIG. 162. MILKING STOOLS

Milking Stool (No. 2)

1. *Purpose.* This stool is exceedingly easy to make, and is liked by many. It is a little easier to upset, and is a little heavier than the three-legged stool.

2. *Material required.*

a. *Lumber.* Soft, close-grained wood, such as white pine, is well adapted for the purpose.

No. of Pieces	Dimensions	Purpose
1	4″ × 4″ × 9 3/16″	Legs
2	1 3/16″ × 9″ diameter	Top

3. *Directions.*

a. Screw the top board fast to the leg.

b. Fit the lower top boards around the leg, and screw them to the upper board.

c. If a bracket or a key-hole saw is not available to cut the circular top, this may be made rectangular.

d. Paint or enamel the stool white.

Milking Stool (No. 3)

1. *Purpose.* This stool is of the bench type, and has good features. The dimensions of this as well as the other milking stools shown may be varied somewhat to suit the persons who are to use them.

2. *Material required.*

a. *Lumber.* White pine, cypress, cedar, etc.

No. of Pieces	Dimensions	Purpose
1	1 3/16″ × 7 3/4″ × 12″	Top
2	1 3/16″ × 7 3/4″ × 9 5/16″	Legs
2	1 3/16″ × 1 3/4″ × 12″	Sides

b. *Hardware.* About 2 doz. 8d. finishing nails.

c. *Paint.* A small amount of white paint.

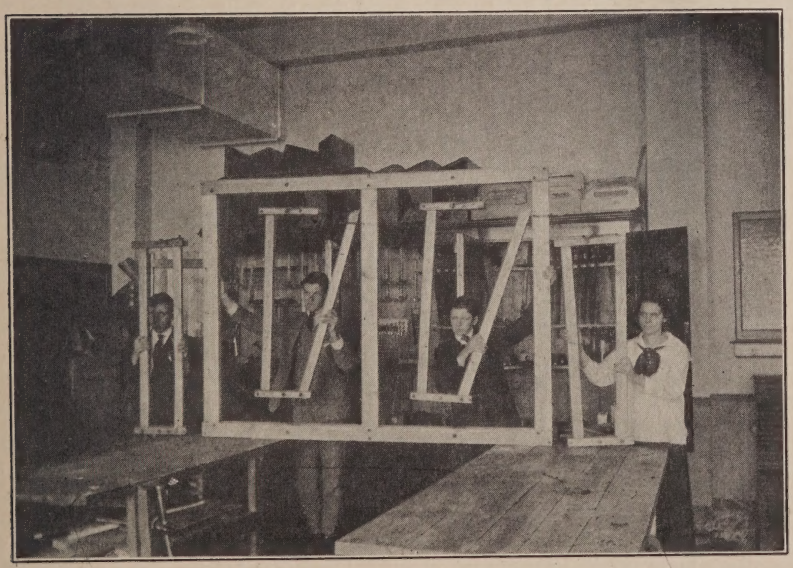


Fig. 163. Stanchions

Made by pupils at Towanda, Pa. Mr. B. A. Rockwell, instructor. Photograph, courtesy of Mr. B. A. Rockwell, County Supervisor of Agricultural Education, Condersport, Pa.

3. *Directions.*
   a. Find the length and the bevel cuts for the legs with a framing square as shown by using 1½″ on the tongue, and 9⅜₁₆″ on the blade of the square.
   b. The bottoms of the legs should be in a vertical line with the ends of the top.
   c. Nail or screw the parts together securely and finish with several coats of white paint.

Swinging Stanchion

1. *Purpose.* The swinging type of stanchion is especially desirable

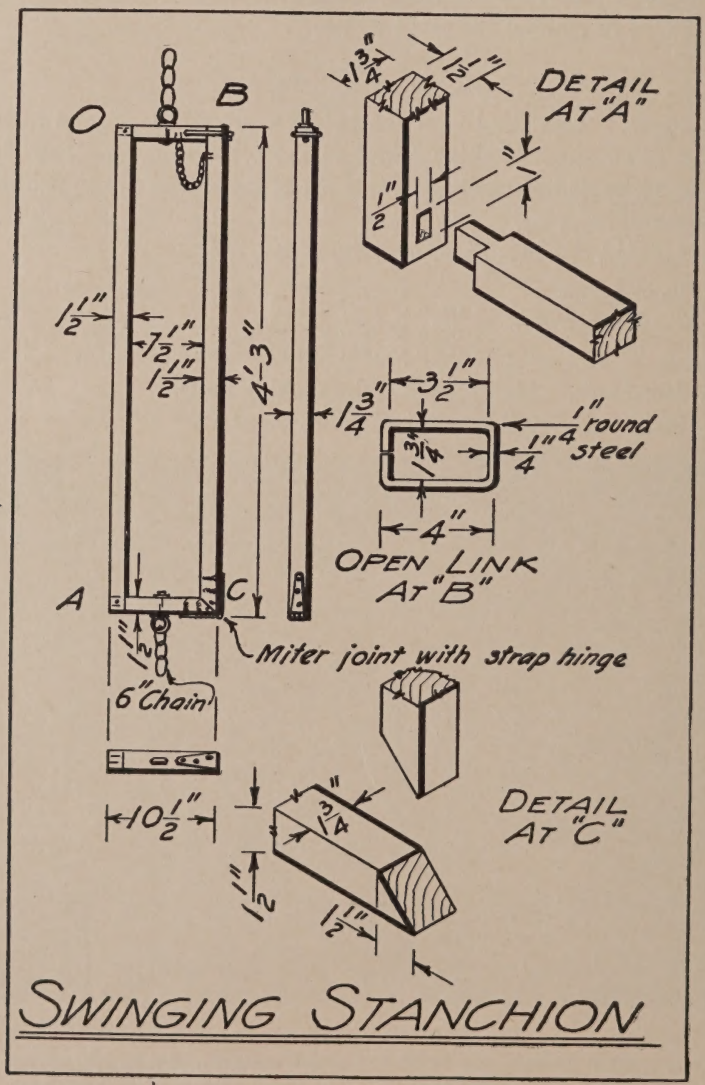


FIG. 164. SWINGING STANCHION

for dairy cows. It provides a maximum of freedom of movement and yet keeps the animals within proper bounds. The stanchion should be so hung that the cow can eat from the manger while reclining.

2. *Material required.*

a. *Lumber.* Oak, hickory, chestnut, etc.

No. of Pieces	Dimensions	Purpose
2	1½″ × 1¾″ × 4′ 3″	Sides
1	1½″ × 1¾″ × 10½″	Bottom
1	1½″ × 1¾″ × 9″	Top

b. *Hardware.*

1 lineal foot of wrought iron chain.
1 lineal foot of light iron chain.
2 ¼″ eye bolts, 1¾″ shanks.
1 ¼″ × 1¾″ × 3½″ open stirrup link.
2 ¼″ × 3″ × 3″ angle irons with screws.
4 ⅛″ × 3″ × 3″ angle plates with screws.
2 small screw eyes or staples.

c. *Oil.* A small quantity of boiled linseed oil.

3. *Directions.*

a. Select lumber with straight grain, and free from imperfections.

b. The joints "A" and "O" are made with a "through mortise," and are "pinned." This is done by drilling a hole through the assembled joint at the points marked with dots in the drawing, and then driving a piece of 8d. nail into this hole, and almost through the joint in such a way as to lock or pin it together permanently.

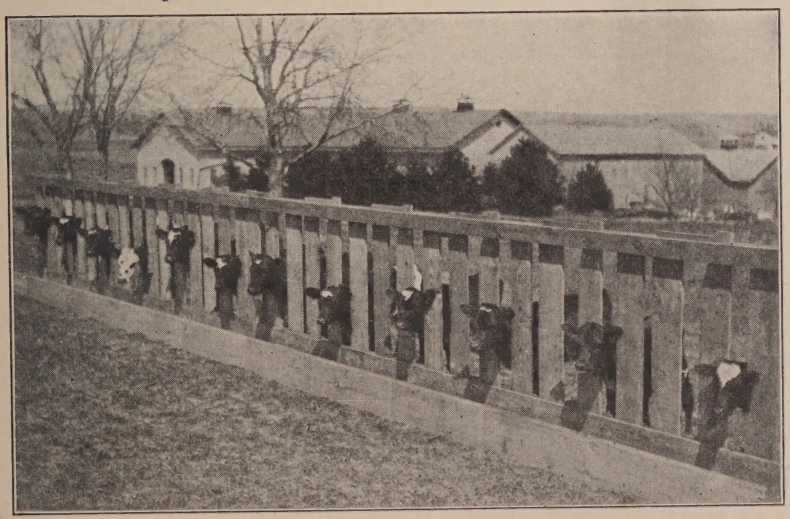


Fig. 165. "The College Choir" at the Kansas State Agricultural College

Photograph, courtesy of Professor J. B. Fitch, Head of the Department of Dairy Husbandry.

c. The open link at "B" may be bent up cold out of Norway iron, or mild steel.

d. The joint at "C" is a miter (45 degree) cut, bound by a strap hinge.

e. In order to strengthen the joints "O" and "A" place angle irons on the inside angles and use angle plates on the sides.

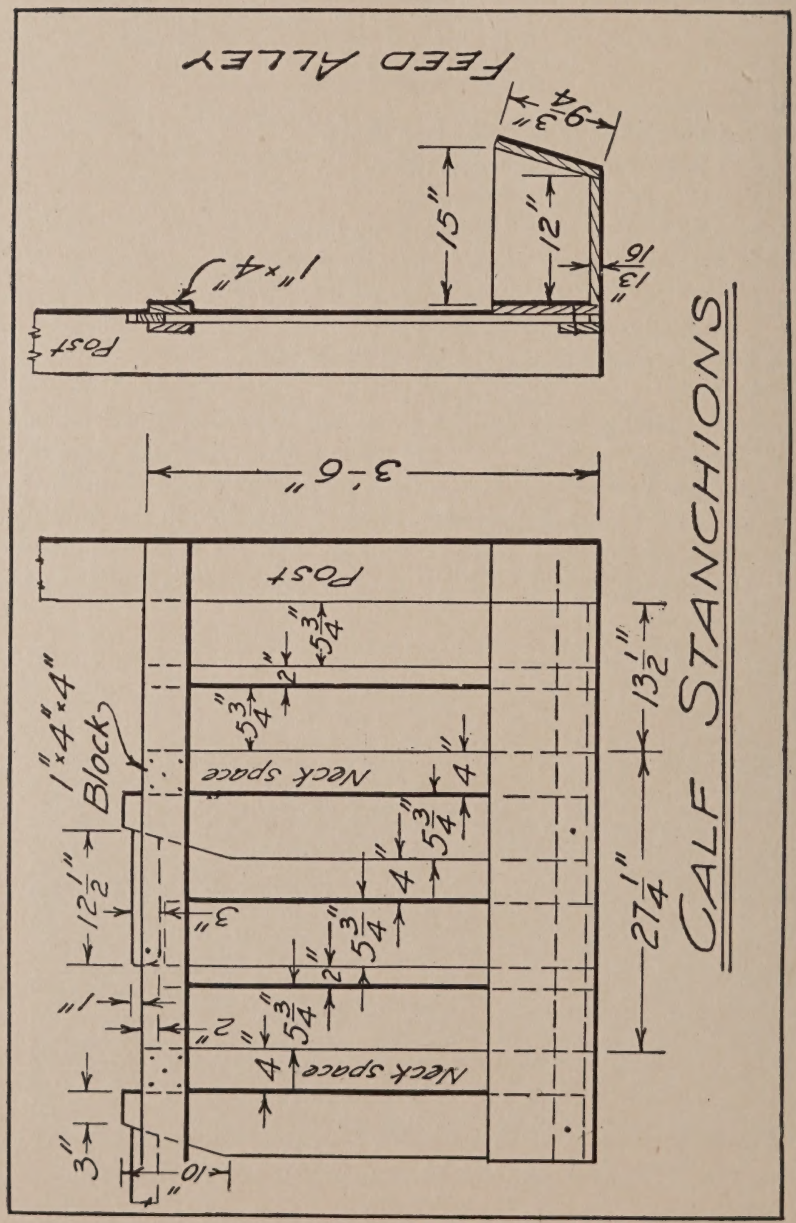


FIG. 166. CALF STANCHIONS

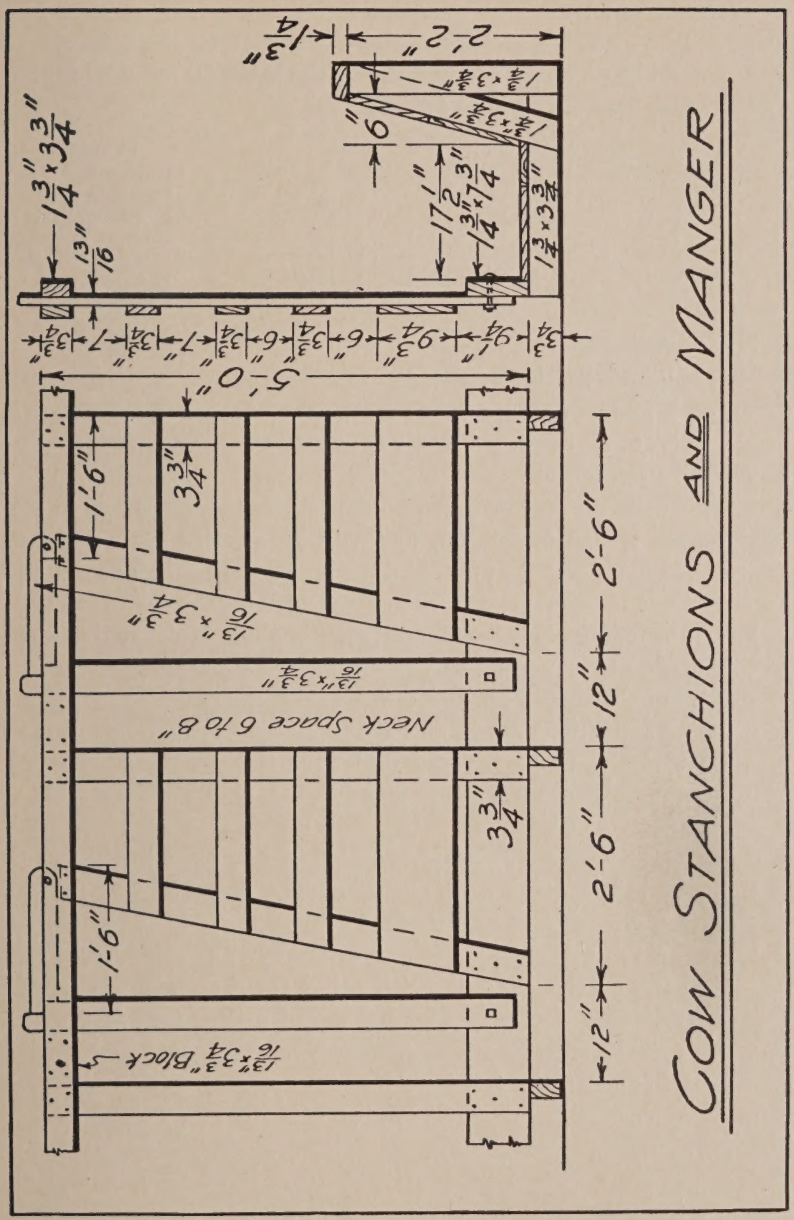


FIG. 167. COW STANCHIONS AND MANGER

Calf Stanchions

1. *Purpose.* Calf stanchions such as shown in Figs. 165 and 166 provide a cheap and effective way for confining calves while they are being fed. After their meals they are released and given the freedom of their pasture or yard.

2. *Material required.*

a. *Lumber.* Moderate-priced lumber will serve the purpose. It should be planed. The amount of the material required for a set of four stanchions is as follows.

No. of Pieces	Dimensions	Purpose
8	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 3'\ 7''$	Uprights
4	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 3'\ 3''$	Uprights
3	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 10'$	Horizontal ties
1	$1\frac{3}{16}'' \times 11\frac{3}{4}'' \times 10'$	Bottom of trough
2	$1\frac{3}{16}'' \times 9\frac{3}{4}'' \times 10'$	Sides of trough
4	$1\frac{3}{16}'' \times 3'' \times 12\frac{1}{2}''$	Latches
4	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 4''$	Blocks

b. *Hardware.*

¼ lb. 8d. finishing nails.

2 lb. 8d. common wire nails.

9 ¼″ × 4″ carriage bolts, with washers.

3. *Directions.*

a. The construction should be adapted to the place where stanchions are to be placed, and will necessarily vary somewhat depending upon the number to be built. They may be put up in sections in school shops to be assembled on the home farms.

b. The swinging parts are pivoted on ¼″ bolts. Nails might be used but are not as permanent.

c. All lumber should be surfaced.

d. If the stanchions are to be built in places having no floor, it will be advisable to place cleats under the trough.

Cow Stanchions and Manger

1. *Purpose.* Cows are usually arranged in two rows in the barn as this is a labor-saving arrangement. The animals may be faced toward a central feed alley, or may face outward. In either case some form of stanchion which gives the cows as much freedom of movement as is consistent with other requirements is desirable. The stanchions shown in Fig. 167 are of a type that farmers can easily make, and they are not expensive.

2. *Material required* (for 2 stanchions and manger).

a. *Lumber.* Yellow pine, fir, spruce, etc.

No. of Pieces	Dimensions	Purpose
1	$1\frac{3}{4}'' \times 7\frac{3}{4}'' \times 7'$	Front of manger
1	$1\frac{3}{16}'' \times 11\frac{3}{4}'' \times 7'$	Bottom of manger
1	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 7'$	Bottom of manger
2	$1\frac{3}{16}'' \times 11\frac{3}{4}'' \times 7'$	Back of manger
3	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 12'$	Framing material
2	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 7'$	Manger rail
2	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 7'$	Stanchions
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 5'\ 1''$	Stanchions
4	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 5'$	Stanchions
12 lineal feet	$1\frac{3}{16}'' \times 3\frac{3}{4}''$	Stanchions
5 lineal feet	$1\frac{3}{16}'' \times 9\frac{3}{4}''$	Stanchions
2	$1\frac{3}{16}'' \times 3'' \times 1'\ 6''$	Stanchions

b. *Hardware.*

¼ lb. 8d. finishing nails.
2 lb. 8d. common wire nails.
4 ¼″ × 5″ carriage bolts with washers.
4 ¼″ × 3½″ carriage bolts with washers.

3. *Directions.* The construction is similar to that of the calf stanchion which has just been presented.

Milk Record Case

1. *Purpose.* The milk record case shown in Fig. 169 has been designed by J. D. McVean, Director of Vocational Agriculture, Edinboro, Pennsylvania. Its purpose is to provide a convenient means of keeping milk records clean, and in a convenient place.
2. *Method of using the case.*
   a. The milk record is attached with thumb tacks to a sliding board which is adjustable for height by means of wing-nuts at the sides of the case. A piece of window pane protects the record as it moves upward.

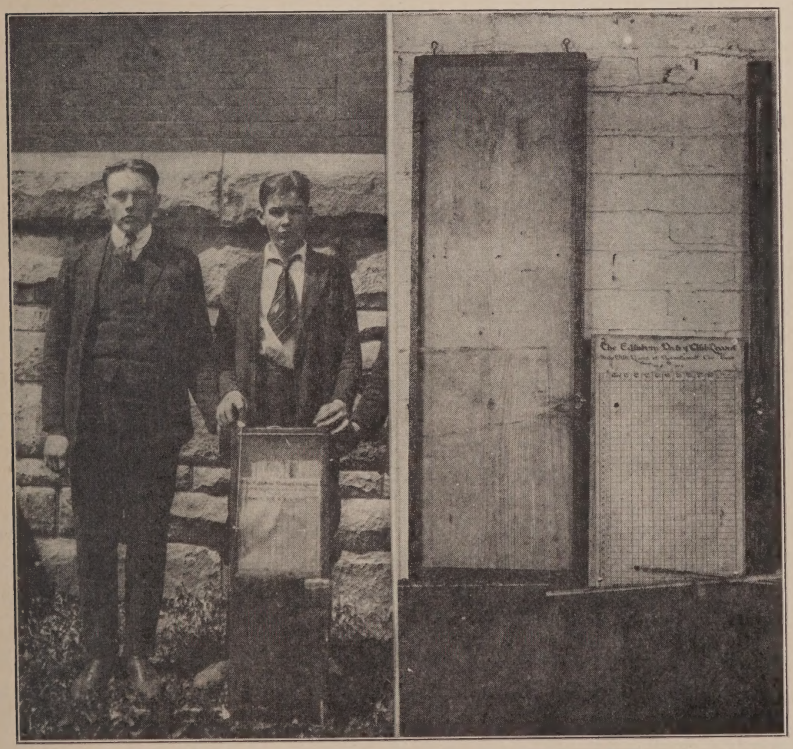


FIG. 168. THE EDINBORO MILK RECORD CASE

Designed by Mr. J. D. McVean, and built by his agricultural pupils, at Edinboro, Pa.

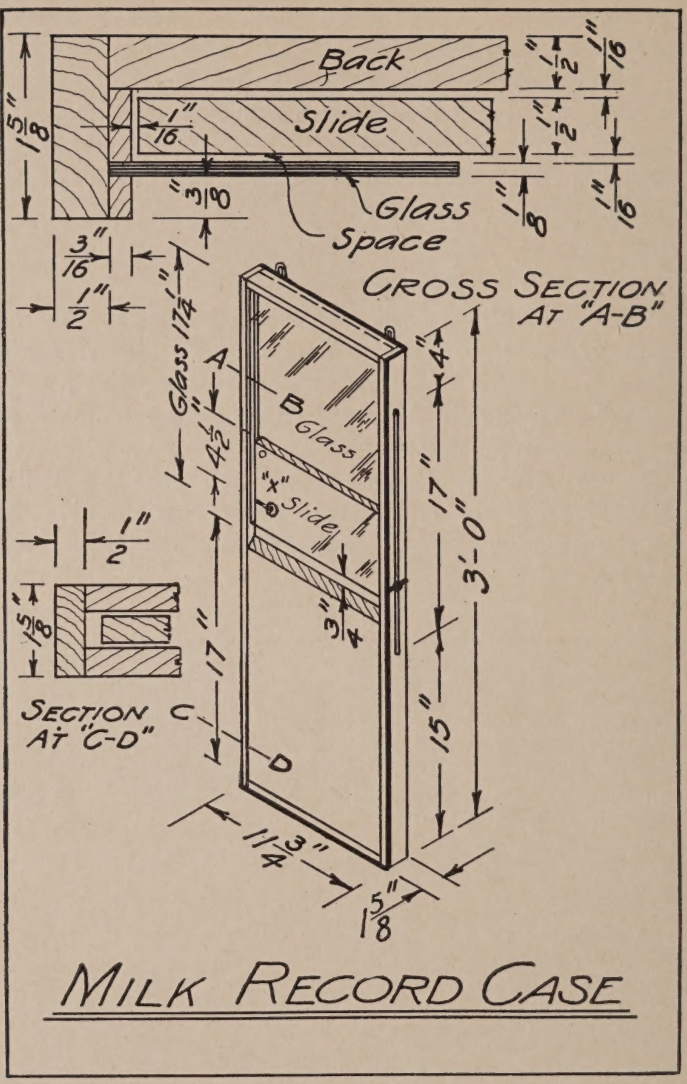


Fig. 169. Milk Record Case

b. The lower part of the front of the case is protected with a board which may be hinged in position, or may be held by screws. The latter method is simpler, but more time is required when the records are placed in the case.

c. The case may be hung on the wall at a convenient height, by means of padlock eyes, or screw-eyes attached near the top of the case.

3. *Material required.*

a. *Lumber.* White pine, whitewood, cypress, fir, etc.

No. of Pieces	Dimensions	Purpose
1	½″ × 10¾″ × 17″	Front
2	½″ × 1⅝″ × 3′	Sides
2	½″ × 1⅝″ × 10¾″	Top and bottom
1	½″ × 10¾″ × 2′ 11″	Back
1	½″ × 9¾″ × 17″	Slide
2	3/16″ × ⅝″ × 2′ 11″	Stops
2	3/16″ × ⅜″ × 17¼″	Stops

b. *Hardware.*

2 padlock eyes, or else screw-eyes.

¼ lb. 8d. common wire nails.

2 ¼″ × 4″ bolts with washers and wing-nuts.

Small quantity of ⅝″ wire brads.

c. *Glass.*

1 piece of double strength window glass, 10¾″ × 17¼″.

4. *Directions.*

a. The cross-section shown in Fig. 169 shows how much space should be allowed to assure freedom of movement for the slide.

b. The slots in the sides of the case should be ⅛″ wider than the diameter of the bolts with wing-nut attached that work in these slots.

c. Bore ¾″ holes from the back of the slide, and ⅜″ deep as indicated at "X." Next bore ¼″ holes from the edges of the slide directly into the first holes and insert bolts.

d. Cut off the heads of the bolts, and thread ends for wing-nut. Insert other end into ¼″ holes, put nut in the ¾″ × ⅜″ holes and turn the bolts into the nuts.

e. Fasten the glass between stops as shown in the cross-section. Fasten stops with ⅝″ wire brads.

f. Bevel the board covering lower half of the front of the case at the top edge at an angle of about 30 degrees. This makes it easier to record on the sheet that is exposed at that point.

Silage or Feed Cart

1. *Purpose.* The cart shown in Fig. 170 is such as can be built by farmers and by pupils studying agriculture. It is a great labor saver in the feeding process. The size will vary with the size of the herd to be fed. Various forms of wheels may also be adapted to such home-made carts. For example 2 large wheels may be used, something on the order of the wheels on push-carts, or the cart can be placed on four wheels. The drawing shows 2 wheels and 2 swivel caster wheels. This permits the cart to be turned around easily.

2. *Material required.*

a. *Lumber.* Old crating material may be used. Light lumber such as white pine is to be preferred.

No. of Pieces	Dimensions	Purpose
3	$1\frac{3}{4}'' \times 12'' \times 4'$	Bottom
50 square feet	$\frac{13}{16}''$ boards	Body of cart
24 lineal feet	$\frac{13}{16}'' \times 3\frac{3}{4}''$	Cleats

b. *Hardware.*

1 pr. 10″ cast iron wheels on 3′ 8″ axle.

2 heavy swivel wheels about 3″ in diameter.

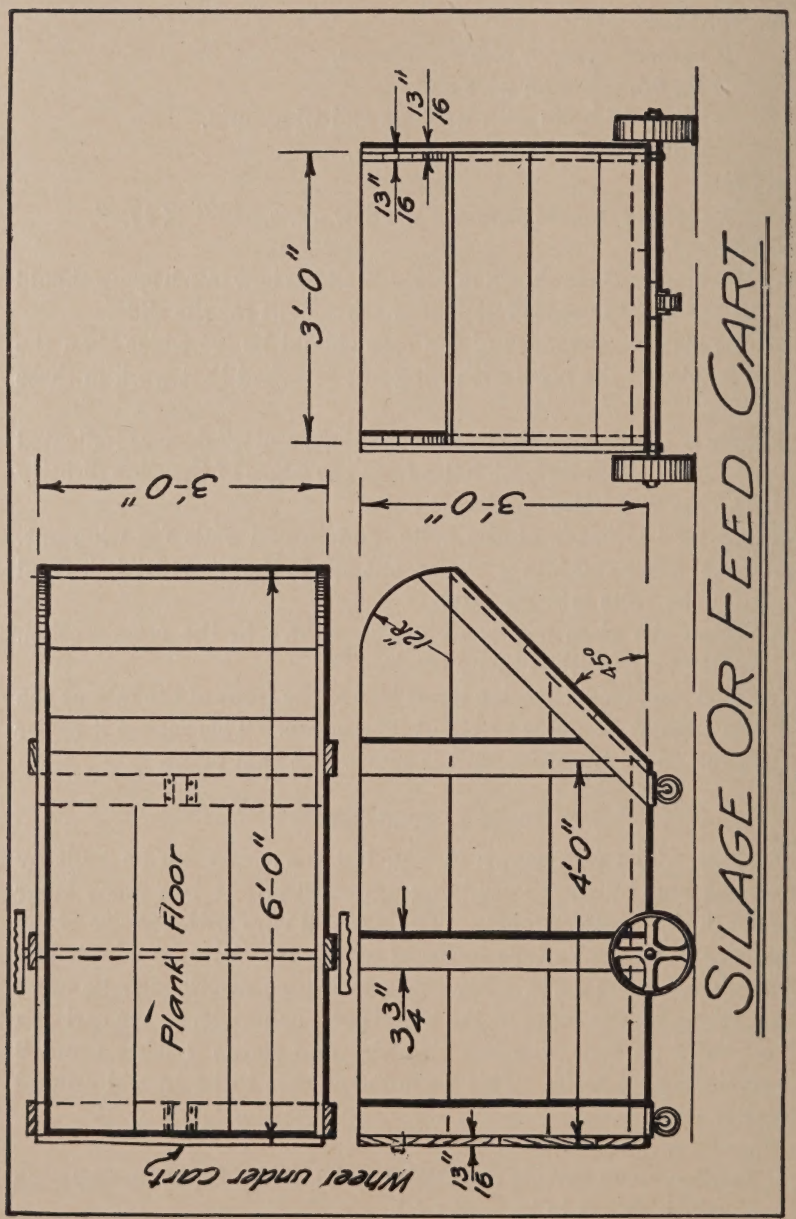


Fig. 170. Silage or Feed Cart

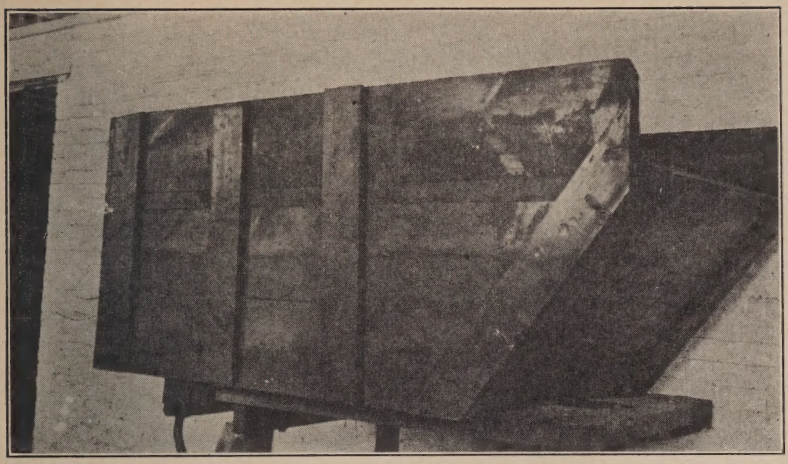


FIG. 171. SILAGE FEED CART IN PROCESS OF CONSTRUCTION

The work is being done by vocational agricultural pupils at Edinboro, Pa. Mr. J. D. McVean, instructor. Old crating material is being used.

1 lb. 8d. common wire nails.
2 heavy staples or short pieces of strap iron to hold main axle.
4 2″ spring steel cotter pins.

3. *Directions.*
   a. Fasten the bottom planks to a couple of cross-cleats. The axle for the wheels is fastened to the bottom planks by bands of strap iron.
   b. Clinch all nails well, surface all boards, and make the joints tight.
   c. Paint the outside of the feed cart if desired, using a good brand of "outside" paint.

Lever Butter Worker

1. *Purpose.* Lever butter workers can be used to advantage where butter is made without the use of power machinery. Such workers are extensively used on farms all over the United States.
2. *Material required.*
   a. *Lumber.* Non-resinous lumber such as white pine, or western spruce.

No. of Pieces	Dimensions	Purpose
2	$\frac{13}{16}$″ × 3″ × 22″	Back legs
1	$\frac{13}{16}$″ × 3″ × 21″	Front legs
2	$\frac{13}{16}$″ × 1¾″ × 2′ 8″	Braces
1	$\frac{13}{16}$″ × 1¾″ × 1′ 6″	Braces
2	$\frac{13}{16}$″ × 10¼″ × 3′ 1″	Top
2	$\frac{13}{16}$″ × 3¾″ × 3′ 1″	Sides
1	$\frac{13}{16}$″ × 3¾″ × 2′ 6″	Cleat
1	$\frac{13}{16}$″ × 3¾″ × 1′ 3″	Cleat
1	2¼″ × 3″ × 3′ 9″ (hard wood)	Lever

b. *Hardware.*

1 piece ⅛″ × 1″ × 12″ end plate.
2 doz. 1¼″ No. 8 or 10 flat head bright screws.
1 piece ¼″ × 5″ round steel or iron.
½ lb. 6d. wire finishing nails.
½ lb. 8d. wire finishing nails.

c. *Paint.* Small quantity of white paint for outside of worker.

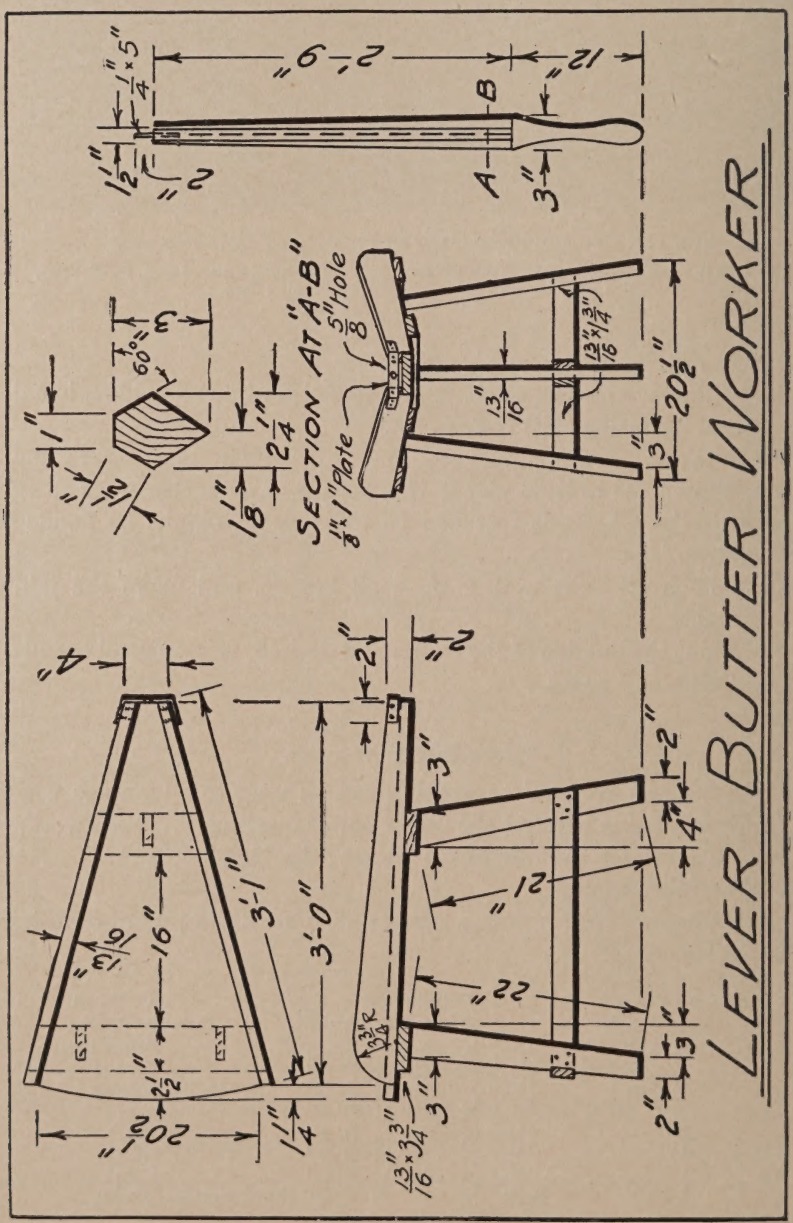


Fig. 172. Lever Butter Worker

3. *Directions.*

a. Get the correct bevels for the legs by using a framing square. Use a 3 and 22 cut for the back legs and a 4 and 21 cut for the front legs. The side splay or spread is 3″ from the vertical on the back legs.

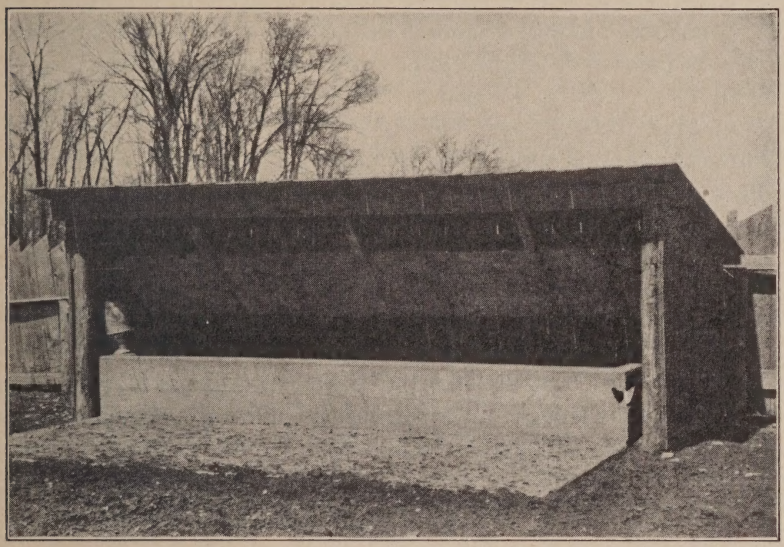


FIG. 173. WATER TANK WITH PROTECTING SHED, AND FLOOR TO PREVENT MUD-HOLE

Photograph, courtesy of Portland Cement Association.

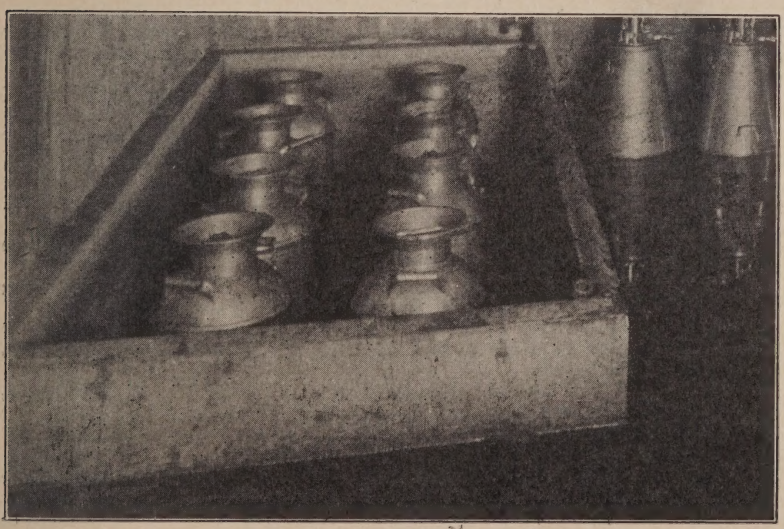


FIG. 174. MILK COOLING VAT MADE OF CONCRETE

Photograph, courtesy of Portland Cement Association.

b. The top or main surface with its two adjacent sides should be water-tight and smooth. To avoid nail holes as much as possible in these surfaces use screws for the cross-cleats. Nails driven through the top into the legs should be set and the holes should be puttied.

c. Paint is to be used only on such parts of the butter worker as do not come in direct contact with the butter. The lever is not to be painted or finished in any way with oils or varnish.

Water Tank

Pure cold water is appreciated by animals quite as much as by human beings. An inexpensive and yet very effective protection for a water trough used in connection with dairy husbandry is shown in Fig. 173.

Milk Cooling Vat

Another very desirable project, likewise of concrete, and for use in connection with the dairy business is a milk cooling tank such as is shown in Fig. 174. The construction is practically the same as is required for a concrete watering trough. The dimensions, of course, should be worked out in conformity with specific local needs. See the Index for directions concerning the concrete work.

REFERENCES

1. *Free bulletins and circulars.*
Concrete Milk Cooling Houses, Suggested Designs for. Portland Cement Association.
Concrete Troughs, Tanks, and Cisterns. Portland Cement Association.
Construction and Equipment of Dairy Barns. Nicholls, W. D. Bulletin No. 179, 1914, Agricultural Experiment Station, Lexington, Ky.
Dairy Barn and Milk Houses, The. How to Construct Them. Hundertmark, R. E. Popular Bulletin No. 95, 1915, Agricultural Experiment Station, Pullman, Wash.
Farm Buildings. Lewis, Frank C. Circular No. 100, 1921, Agricultural Experiment Station, Purdue University, Lafayette, Ind.
Farm Ice House, The. Robb, B. B., and Strahan, J. L. Lesson 135, 1918, Cornell Reading Course for the Farm, College of Agriculture, Ithaca, N.Y.
Factors and Methods in the Profitable Production of Sanitary Milk. Nicholls, W. D. Bulletin No. 206, 1917, Agricultural Experiment Station, Lexington, Ky.
Ice Houses, and the Use of Ice on the Dairy Farm. Bowler, John T., and Lambert, Guy M. Farmers' Bulletin No. 623.
Inexpensive Appliances and Utensils for the Dairy. Nicholls, W. D. Circular No. 6, 1915, Agricultural Experiment Station, Lexington, Ky.
Manufacture of Dairy Butter, A Study of the Methods of Making Farm Butter. Anthony, E. L. Bulletin No. 135, 1915, Agricultural Experiment Station, State College, Pa.
Milk House for Texas, A. Rhodes, Leroy. Circular No. 15, 1916, Agricultural Experiment Station, College Station, Texas.
2. *Reference books.*
Eckles, C. H., and Warren, G. F., *Dairy Farming.*
Larson, Carl W., and Putney, Fred S. *Dairy Cattle Feeding, and Management.* John Wiley & Sons.
Shaw, Thomas. *The Management and Feeding of Cattle.* Orange Judd Co.
Stocking, W. A. *Manual of Milk Products.* The Macmillan Co.

CHAPTER XIV

RELATING TO GENERAL FARM PROJECTS

A NUMBER of appliances, pieces of equipment, and certain farm structures are general in nature in the sense that they are used in connection with more than one phase of agriculture such as dairy husbandry and field crop production. A rigid classification has not been attempted as local requirement and conditions vary. Projects presented in this chapter may well be used to supplement those in other chapters. For example, farm gate construction may be taught in connection with field crops, animal husbandry, or dairy husbandry.

Singletree

1. *Purpose.* Singletrees vary somewhat in length, thickness and method of construction depending upon the use for which they are designed. Plow singletrees are 26″ and 30″ long while wagon singletrees are made in lengths of 30″, 36″, and 38″.
2. *Material required.* Straight grained hickory should be used. A piece of hickory 1¾″ × 2¾″ × 36″ will serve the purpose. The iron fittings may be purchased, made, or can be taken from another singletree.
3. *Directions.*
   a. Bring the singletree to the desired shape by the use of a drawing knife, spoke shave, and plane.
   b. Fit the steel parts such as ferrules or clips.
   c. Finish with several coats of boiled linseed oil.

Neckyoke

1. *Purpose.* Ordinary wagon neckyokes for horses are made in 38″ and 42″ lengths. The rings and ferrules can be purchased more cheaply than they can be made by hand, hence they are not shown in Fig. 176.
2. *Material required.* A piece of straight-grained hickory 1¾″ × 3″ × 38″.
3. *Directions.*
   a. Work the piece to the desired shape as in the case of the singletree.
   b. Fit the ferrules and plates.
   c. Finish with boiled linseed oil, or paint to match wagon.

Doubletree

1. *Purpose.* A doubletree set is made up of a doubletree and two singletrees. The doubletree serves as a beam to distribute the

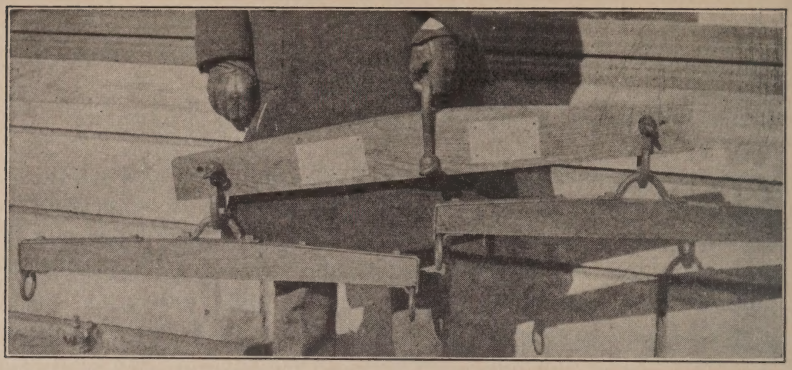


FIG. 175. DOUBLETREE

Made by John Yost and Elmer Kline, pupils at the Benton (Pa.) Vocational School. Mr. A. C. Sutcliff, instructor.

pulling load between the two horses. Doubletrees are made in lengths of 36″, 40″, 42″, and 48″. They are sometimes bound with light band iron.

2. *Material required.* The steel clevises and bearing plates used on doubletrees can be purchased for a nominal sum. The lumber required consists of a piece of straight-grained hickory 1¾″ × 4½″ × 48″.
3. *Directions.*
   a. Bring the doubletree to proper dimensions by use of a saw and plane.
   b. Bore holes where indicated.
   c. Fit plates and clevises.
   d. Finish with linseed oil, or paint.

Three-Horse Evener

1. *Purpose.* Occasionally it is desired to drive three horses abreast. For this purpose a three-horse evener is used in connection with a doubletree and three singletrees.
2. *Material required.* For the evener a piece of straight-grained hickory, 1¾″ × 5¾″ × 53½″ will serve the purpose.
3. *Directions.*
   a. Bring the evener to the desired shape with a saw and plane.
   b. Bore the end holes where shown. This distributes the pulling load in the ratio of 1 to 2.

Wagon Jack

1. *Purpose.* A wagon jack is a labor-saving appliance used to raise up wagons and buggy axles for any purpose; as, for example, when they are to be greased, or when the wheels are to be soaked in hot linseed oil.

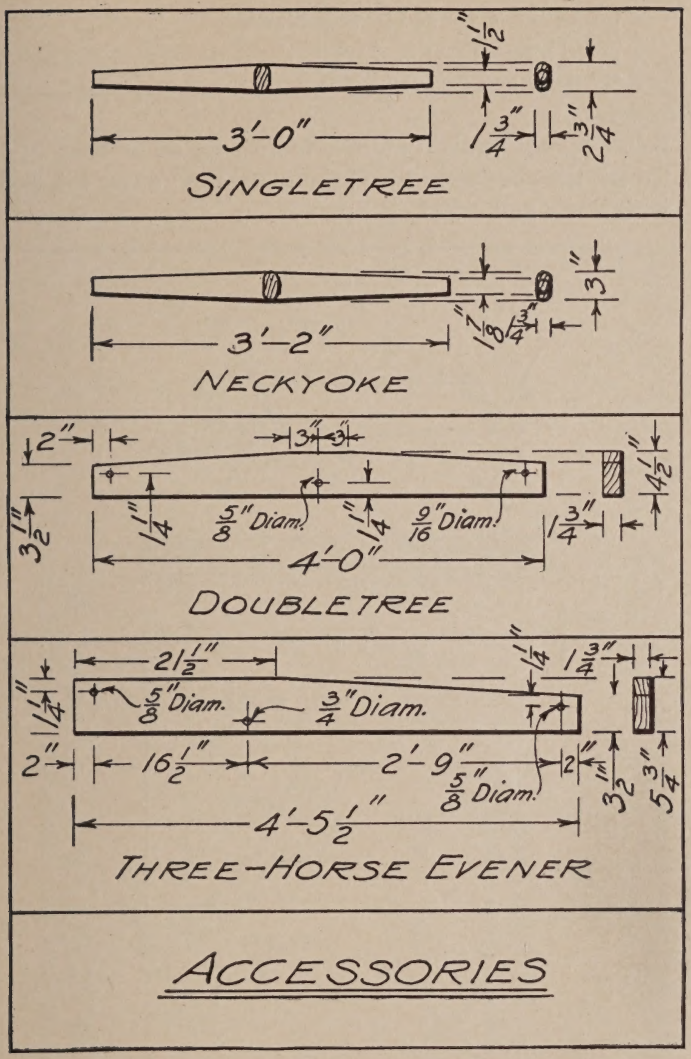


FIG. 176. ACCESSORIES

2. *Material required.*

a. *Lumber.* Hard wood such as oak, maple, or chestnut is better than the softer woods.

No. of Pieces	Dimensions	Purpose
1	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 3'$	Lever
2	$1\frac{3}{16}'' \times 3\frac{3}{4}'' \times 2'\ 2''$	Uprights
1	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 12''$	Foot

b. *Hardware.*

$3\ \frac{3}{8}'' \times 3\frac{1}{2}''$ machine bolts with washers.

$1\ \frac{1}{4}'' \times 1\frac{1}{2}''$ machine bolts with washers.

1 pc. of ⅛″ × ¾″ × 11″ band iron.
1 ⅜″ U stirrup as per drawing.
3 ¾″ flat head bright screws.

3. *Directions.*

a. Select strong, straight-grained lumber for all pieces.

b. To cut the notches in the uprights use a ⅜″ auger bit, and finish with a saw and chisel.

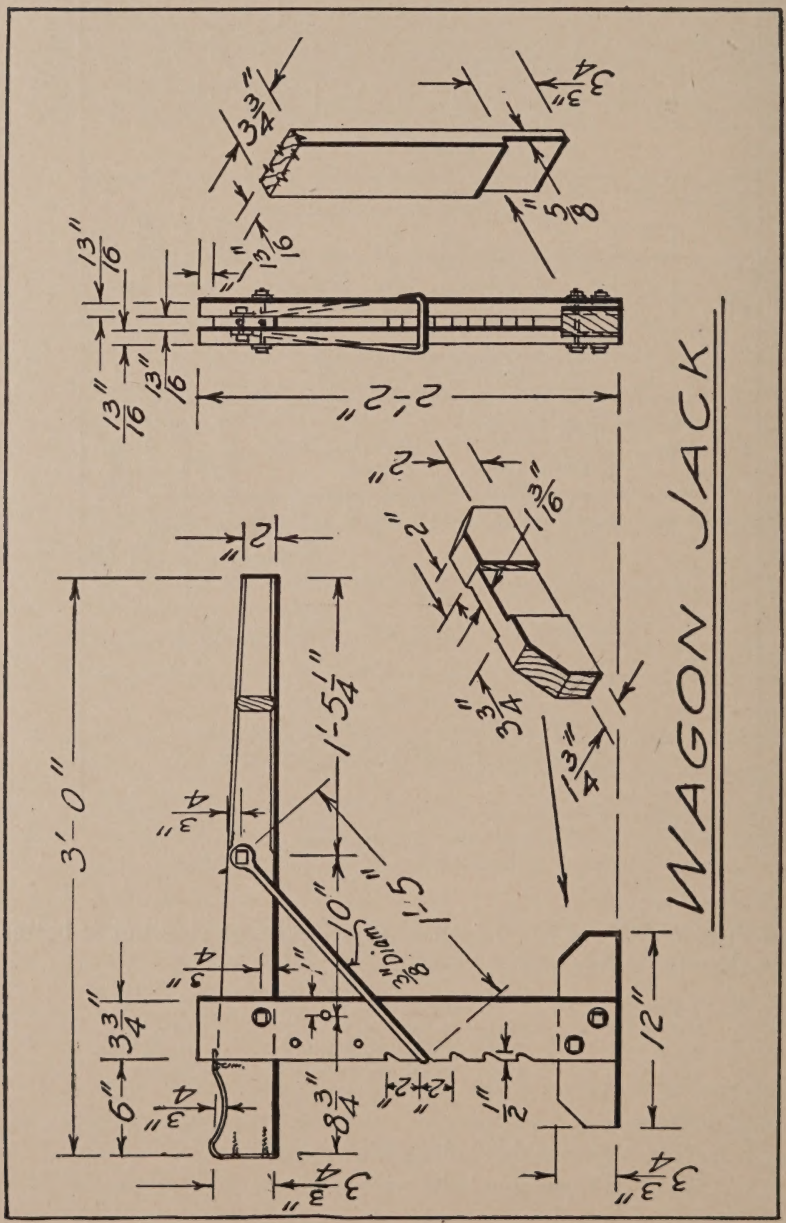


Fig. 177. Wagon Jack

c. Countersink the screw holes in the band iron plate.
d. Finish with linseed oil.

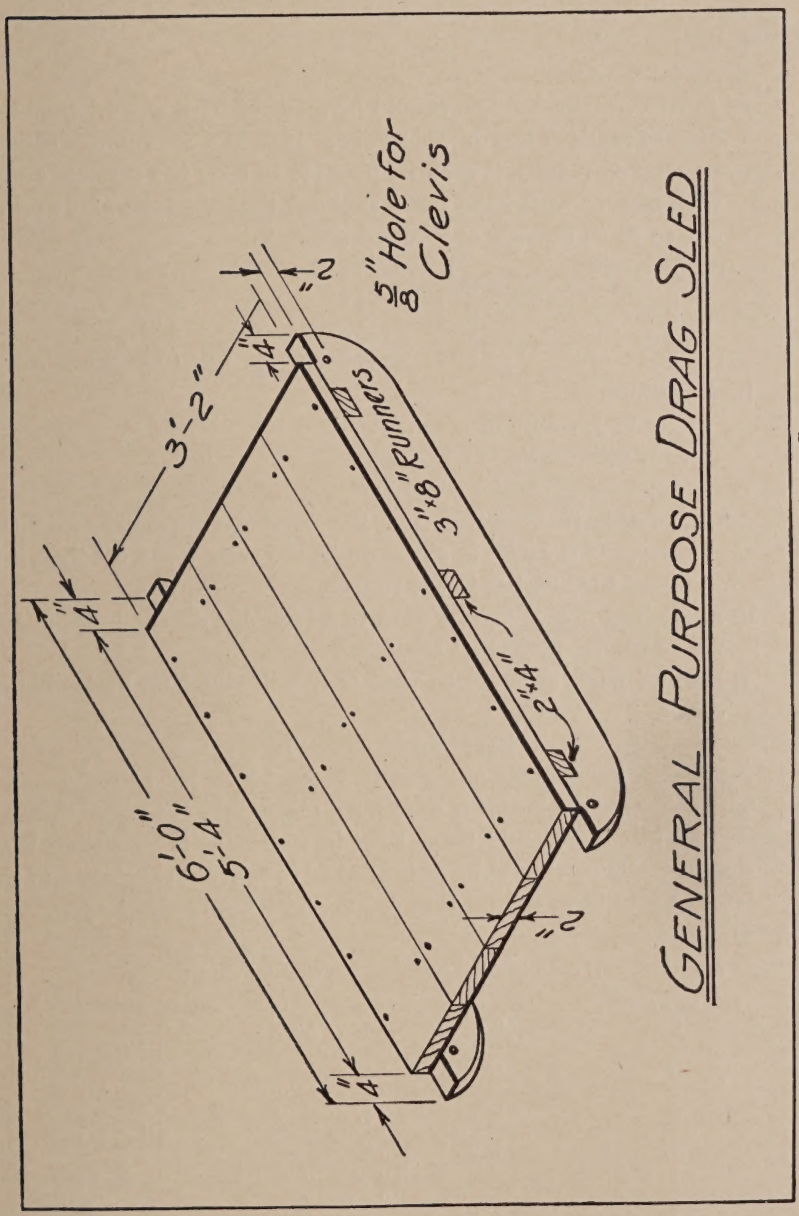


FIG. 178. GENERAL PURPOSE DRAG SLED

General Purpose Drag Sled

1: *Purpose.* There is use on most farms for a simple, sturdy drag sled. It can be used to haul plows and other tools about the farm.

It may also be used for hauling water, stones, and a variety of other objects. Clips may be fastened to the sides so that upright stakes can be inserted which would be helpful in case cord wood is to be hauled.

2. *Material required.*

a. *Lumber.* The runners should be made of hard wood. The top may be made of less durable wood. If hard wood runners cannot be secured readily it may be possible to shoe the runners either with iron or with hard wood saplings that are split and worked out so as to make a half-round shoe.

No. of Pieces	Dimensions	Purpose
2	2″ × 8″ × 6′	Runners
3	2″ × 10″ × 6′	Top
1	2″ × 8″ × 6′	Top
3	2″ × 4″ × 3′ 2″	Cross-ties

b. *Hardware.*

1 lb. 20d. common wire nails.

½ lb. 16d. common wire nails.

3. *Directions.*

a. Care needs to be taken that the cross-ties fit snugly into the runners. It is easier to shave down the cross-ties a bit than it is to re-cut the notches in the runner.

b. Angle-iron braces can be used to advantage on the inner angles where the runners meet the top.

c. Nail all parts securely so that they will stand up under heavy usage.

Farm Gate (No. 1)

1. *Purpose.* Farm gates are usually made 14′ or 16′ between posts. The wider gate is better if wide farm machinery is to pass through it. Farm gates should be as light in weight as is consistent with rigidity. They should be so braced as to prevent sagging, and the latch should be of a kind that cattle and horses cannot open.

2. *Material required.*

a. *Lumber.* White pine, Douglas fir, or Georgia pine.

No. of Pieces	Dimensions	Purpose
2	8″ × 8″ × 7′ 4″	Posts
3	1 3/16″ × 3¾″ × 16′	Rails
2	1 3/16″ × 5¾″ × 16′	Rails
4	1 3/16″ × 5¾″ × 4′ 4¾″	Uprights
2	1 3/16″ × 3¾″ × 4′ 4¾″	Uprights
2	1 3/16″ × 3¾″ × 2′ 3″	Uprights
1	1 3/16″ × 3¾″ × 4′ 6″	Latch
1	1 3/16″ × 4¾″ × 5¾″	Guide block
1	1 3/16″ × 4¾″ × 3¾″	Guide block
1	1 3/16″ × 5¾″ × 12″	Hinge block

b. *Hardware.*

2 gate hinges as per drawing. The upper one to be provided with a shoulder hook and nut, the lower with a pointed shoulder hook.

28 ¼″ × 3″ carriage bolts with washers, or else 1 lb. of 6d common wire nails.

1 ft. of light galvanized iron chain for latch pin.

c. *Paint.* A small quantity of good exterior paint of any desired shade.

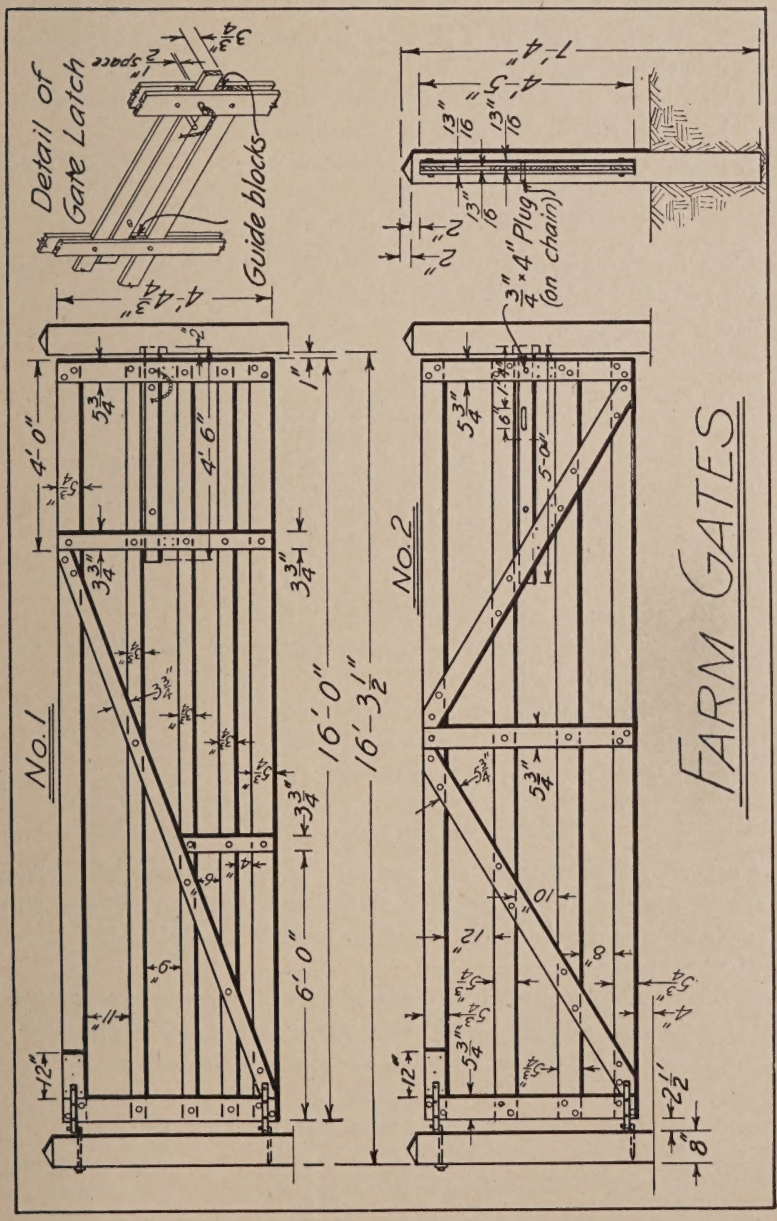


FIG. 179. FARM GATES

3. *Directions.*
   a. Use a framing square in assembling the gate.
   b. Bolts, though more expensive than nails, will be found more satisfactory than the latter.
   c. Set the gate posts 2′ or more into the ground, and tamp them in well.
   d. By using a shoulder hook that runs all the way through the post for the top hinge it is possible to adjust the gate occasionally if it should sag.
   e. The lower shoulder hook is simply driven into the post after a hole slightly smaller than the hook has been bored.
   f. Finish the gate with a priming coat and two coats of good paint.

Farm Gate (No. 2)

1. *Purpose.* This gate differs from the preceding one in the spacing of the rails and in the method of bracing.
2. *Material required.*
   a. *Lumber.* The same kind as gate No. 1.

No. of Pieces	Dimensions	Purpose
2	8″ × 8″ × 7′ 4″	Posts
4	1 3/16″ × 5 3/4″ × 16′	Rails
6	1 3/16″ × 5 3/4″ × 4′ 5″	Uprights
4	1 3/16″ × 5 3/4″ × 8′ 6″	Braces
1	1 3/16″ × 5 3/4″ × 12″	Hinge block
1	1 3/16″ × 3 3/4″ × 5′	Latch
2	1 3/16″ × 5 3/4″ × 5 3/4″	Guide blocks

   b. *Hardware.*
      2 gate hinges as for gate No. 1.
      37 ¼″ × 3″ carriage bolts with washers or else 1 lb. 6d. common wire nails.
      1 ft. light galvanized iron chain for latch pin.
   c. *Paint.* A small quantity of good paint.
3. *Directions.* The same as for gate No. 1.

Wagon Seat

1. *Purpose.* Wagon seats are desirable farm conveniences. They frequently need to be repaired or rebuilt. The springs and clips can easily be purchased in case they need to be replaced.
2. *Material required.*
   a. *Lumber.* White pine, whitewood or yellow poplar is very good for the seat, and hard wood, such as hickory or oak can be used to advantage for the cleats below the springs.

No. of Pieces	Dimensions	Purpose
1	1 3/16″ × 15 3/16″ × 3′ 3/8″	Bottom
1	1 3/16″ × 7 3/4″ × 3′ 3 3/8″	Back
2	1 3/16″ × 5 3/4″ × 16 1 1/16″	Sides
2	1½″ × 1¾″ × 1′ 8″	Lower cleats
2	1½″ × 1″ × 12″	Upper cleats

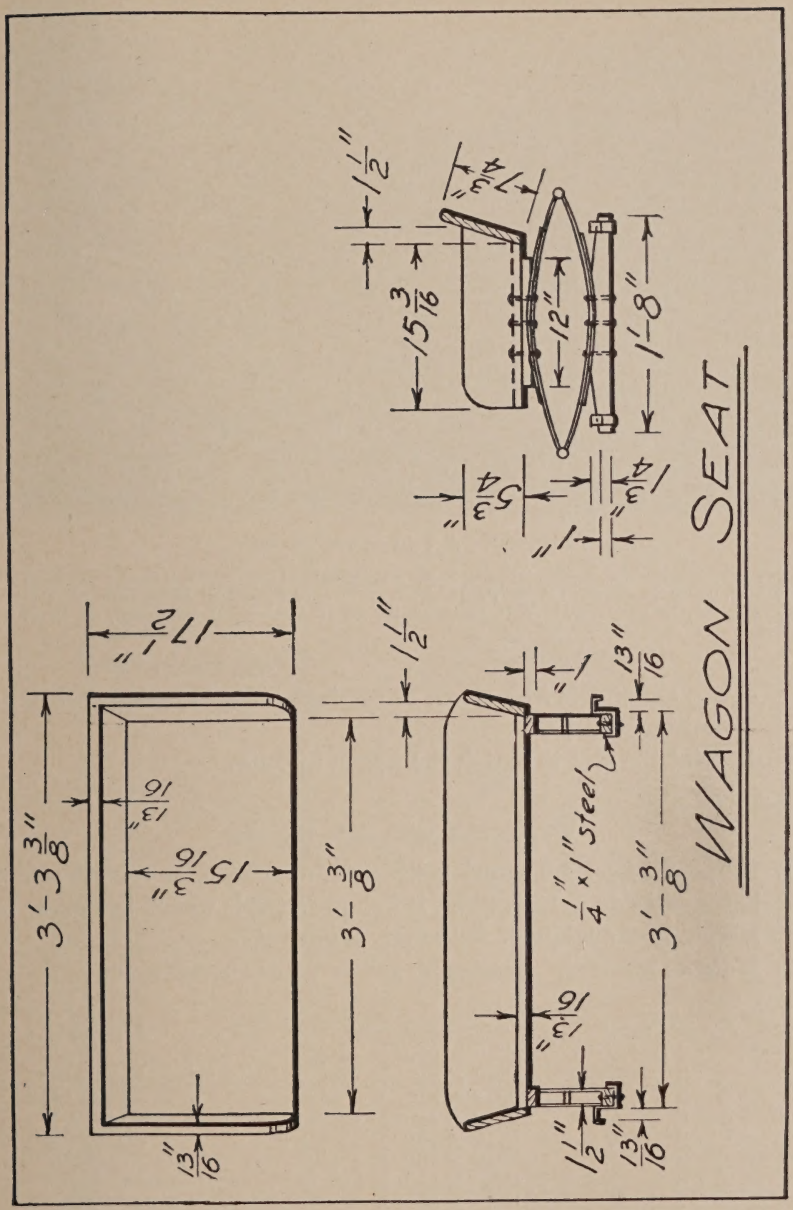


Fig. 180. Wagon Seat

b. *Hardware.*

4 clips and 2 springs as per drawing.
6 ¼″ soft iron rivets 2″ long.
2 doz. 1½″ No. 8 flat head bright screws.

3. *Directions.*

a. Use well seasoned lumber of good quality.
b. Drill for screw holes and countersink for the heads.

FIG. 181. A TRIPLE WAGON BOX

Made by Harold McLaughlin (the boy in the photograph) at the Fairmont, Minnesota, High School, under the direction of Mr. Paul Calrow, Director of Vocational Agriculture. Photograph, courtesy of Mr. B. M. Gile, State Supervisor of Agricultural Education, St. Paul, Minn.

c. Use either soft iron rivets or carriage bolts to fasten springs in position.

d. Paint the seat to match the wagon in color.

Wagon Box with Side Boards

1. *Purpose.* Farmers occasionally need to repair or to rebuild wagon boxes and side boards. Fig. 181 shows a triple wagon box made by Harold McLaughlin of Fairmont, Minnesota.

2. *Material required.* Basswood, yellow poplar or white pine.

No. of Pieces	Dimensions	Purpose
4	$\frac{13}{16}$" × 9½" × 10′ 6"	Floor
2	$\frac{13}{16}$" × 8" × 10′ 6"	Side boards "C"
2	$\frac{13}{16}$" × 8" × 3′ ⅜"	End boards "C"
8	$\frac{13}{16}$" × 1¾" × 13"	Cleats for "C"
2	$\frac{13}{16}$" × 10" × 10′ 6"	Side boards "B"
2	$\frac{13}{16}$" × 10" × 3′ ⅜"	End boards "C"
8	$\frac{13}{16}$" × 1¾" × 18"	Cleats for "B"
2	$\frac{13}{16}$" × 5¾" × 18"	Cleats for "B"
2	$\frac{13}{16}$" × 14" × 10′ 6"	Side Boards "A"
2	$\frac{13}{16}$" × 14" × 3′ ⅜"	End boards "A"
1	$\frac{13}{16}$" × 5¾" × 2′ 10¾"	Dash board
3	1¾" × 4" × 4′ 2"	Sill
1	1¾" × 4" × 3′ 2"	Sill
1	$\frac{13}{16}$" × 10" × 3′ 2"	Sill
2	$\frac{13}{16}$" × 3" × 3′ 2"	Sill
4	$\frac{13}{16}$" × 1¾" × 14"	End cleats for "C"
8	$\frac{13}{16}$" × 1¾" × 2′ 8"	Guide straps
2	$\frac{13}{16}$" × 4" × 2′ 6"	Foot boards

Hardware.

40 carriage bolts ⅜″ × 3½″ for floor.

40 carriage bolts ⅜″ × 2½″ for side and end cleats.

32 carriage bolts ¼″ × 1½″ for strap bolts, side braces and rub irons.

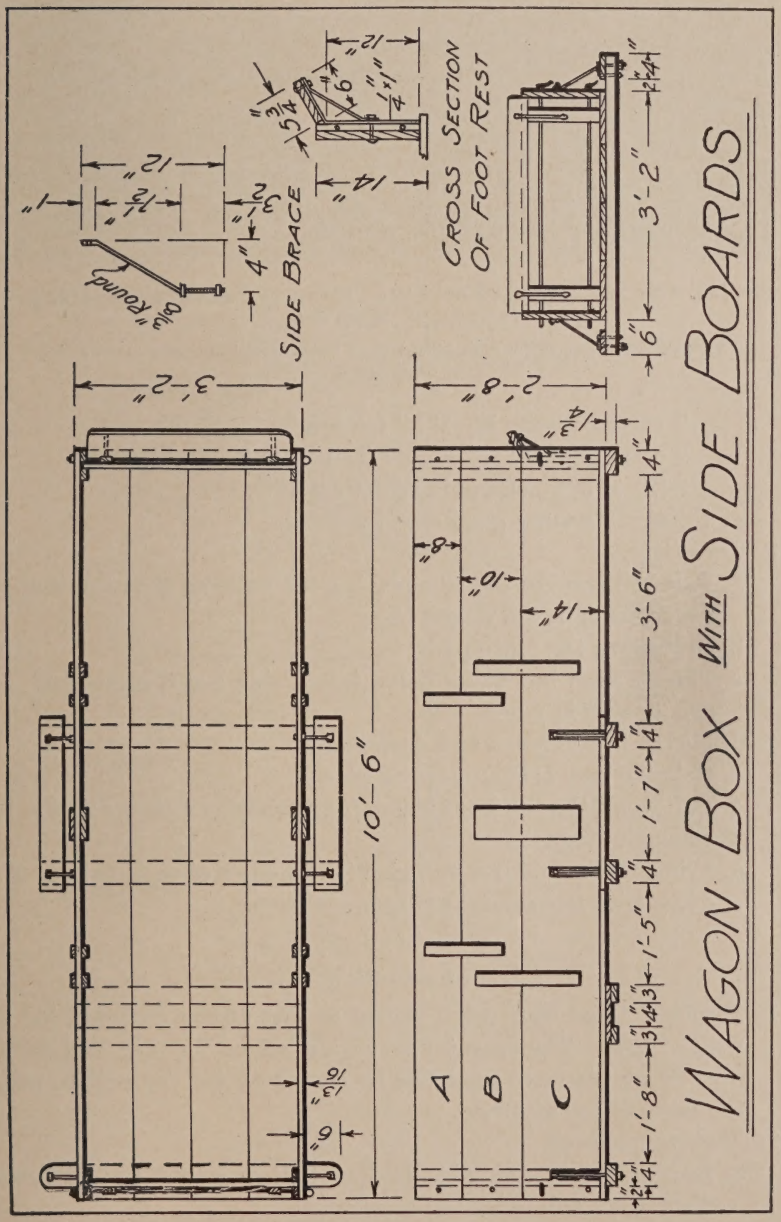


Fig. 182. Wagon Box with Side Boards

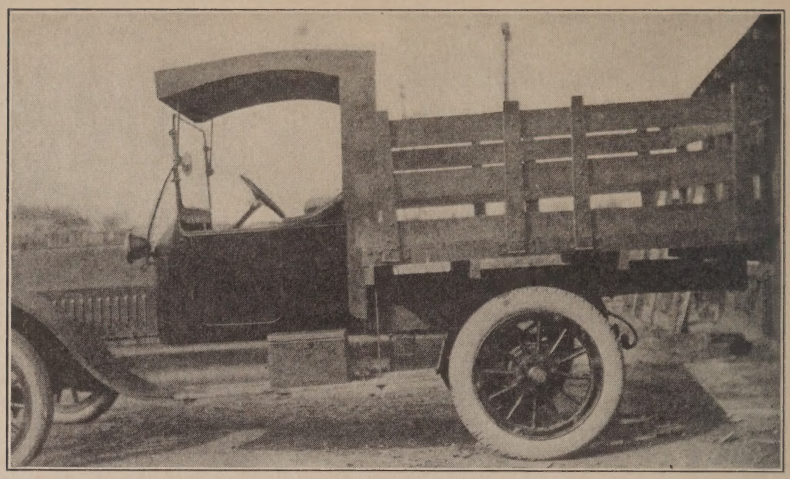


FIG. 183. OLD MACHINE MADE OVER INTO TRUCK BY PUPILS OF THE GARDENA, CALIFORNIA, HIGH SCHOOL

Photograph, courtesy of Mr. J. B. Lillard, State Supervisor of Agricultural Education, Sacramento.

2 carriage bolts ¼″ × 2″ for braces for dashboard.
2 carriage bolts ¼″ × 2½″ for braces for dashboard.
8 ⅜″ × 3′ 3″ end gate rods with nuts.

c. *Paint.* 2 gallons good exterior paint.

3. *Directions.*
   a. Bolt the floor to the sills placing the bolts so that the rounded heads come in the wagon box.
   b. Bolt down the footboards.
   c. Place wagon box strap bolts, fasten side board cleats and bolt side boards in place.
   d. Fasten in end gates and dashboard.
   e. Bolt the rear bolster stops in place.
   f. Bolt down the rub irons where front wheels touch the wagon box when turning.
   g. Prime the wagon box and give it two coats of good paint. Rub down with fine sandpaper between coats.

Snow Plow

1. *Purpose.* The snow plow shown in Fig. 184 is designed for use with a horse. The operator may walk behind the plow and steer it over rough places or may ride by sitting on the cross-tie to which the handles are attached.
2. *Material required.*
   a. *Lumber.* Any available lumber that is sound and of proper dimensions will serve the purpose.

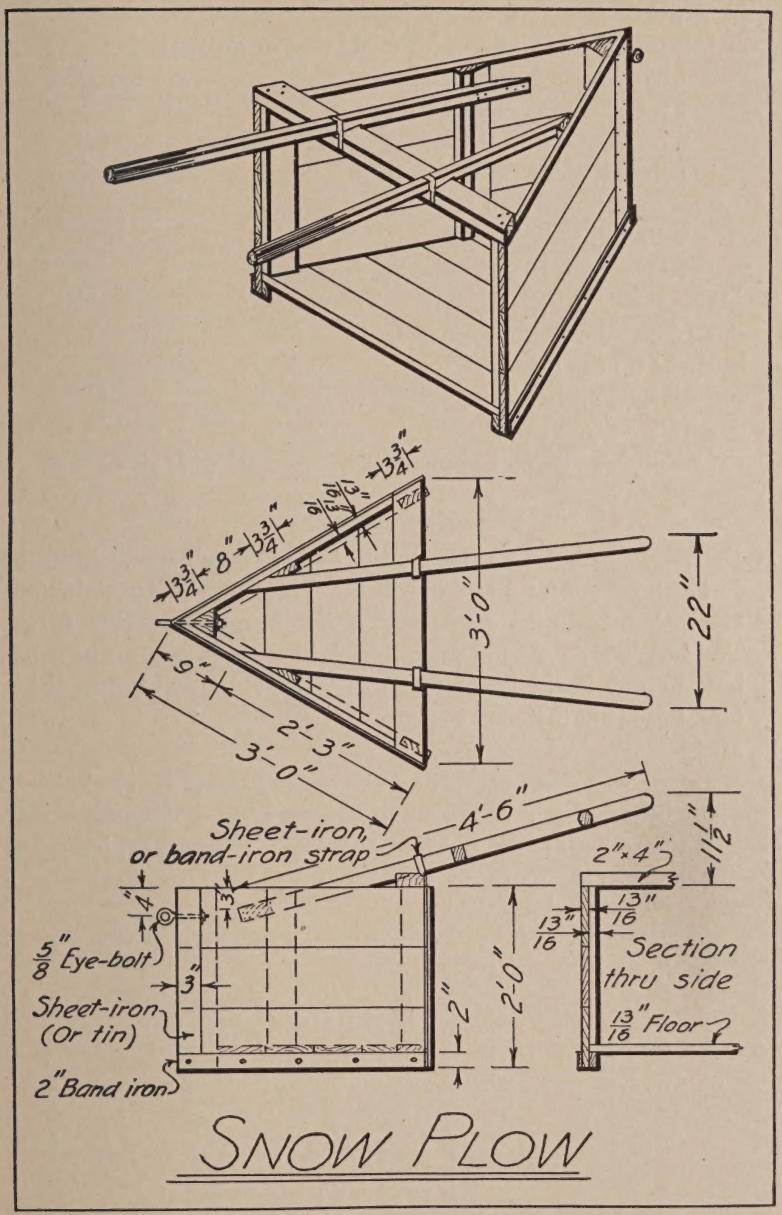


FIG. 184. SNOW PLOW

No. of Pieces	Dimensions	Purpose
6	13/16" × 8" × 3'	Sides
1	3¾" × 3¾" × 2'	Post
1	13/16" × 3¾" × 1' 9"	Uprights
2	13/16" × 2" × 3'	Edging
1	1¾" × 3¾" × 3'	Cross-ties
2	1¾" × 1¾" × 4' 6"	Handles
3 sq. ft.	13/16" × 8"	Bottom

b. *Hardware.*

2 pcs. ¼″ × 2″ band iron (old wagon tire).
1 eyebolt as per drawing.
1 pc. sheet iron 6″ × 24″.
2 pcs. band iron 1/16″ × ¾″ × 14″.
1 lb. 6d. common wire nails.
¼ lb. 8d. common wire nails.
¼ lb. 8d. finishing nails.
10 1¼″ No. 10 flat head bright screws.

3. *Directions.*
   a. Lay out the framework.
   b. Build up the sides.
   c. Nail bottom in place.
   d. Screw on iron shoes.
   e. Fasten handles and bind them to cross-tie with strap iron.

Portable Rabbit Hutch

1. *Purpose.* Rabbits are frequently kept in small numbers by boys and girls on the farm and in suburban places. The portable hutch illustrated herewith represents a number of desirable features. The hutch is so made that either a wire mesh bottom or a board bottom may be used with it. The main structure rests on the bottom, but is not fastened to it in any way.
2. *Material required.*
   a. *Lumber.* Cheap crating or box material may be used although tongued and grooved material specified in the drawing is better. If the material does not fit tightly use tar-paper on the sides, as well as on the roof.

No. of Pieces	Dimensions	Purpose
2	13/16″ × 3¾″ × 8′	Flooring cleats
2	13/16″ × 5¾″ × 9′	Front
3	13/16″ × 2″ × 1′ 10″	Cleats
3	13/16″ × 2″ × 1′ 11″	Cleats
6 lineal feet	13/16″ × 2″	Cleats for door
20 sq. feet	13/16″ × 6″ or 8″ T & G	Flooring
6 sq. feet	13/16″ × 6″ or 8″ T & G	Ends
20 sq. feet	13/16″ × 6″ or 8″ T & G	Back
32 sq. feet	13/16″ × 6″ or 8″ T & G	Roof
8 sq. feet	13/16″ × 6″ or 8″ T & G	Front & partition
2	2″ × 2″ × 9′ 4½″	Sides for screen floor
2	2″ × 2″ × 25½″	Ends for screen floor

32 lineal feet of lath or narrow molding for netting.

b. *Hardware.*

1 pr. 6″ strap hinges with screws.
1 simple door pull with screws.
1 pr. 3″ narrow butt hinges with screws.
1 lb. 8d. finishing nails.

4 lbs. 6d. common wire nails.
¼ lb. roofing tacks with tin washers.
1 lb. ¾″ galvanized wire staples.
1 pc. 1″ poultry netting 18″ × 6′.
1 pc. 1″ poultry netting 28″ × 8′ 4″.

c. *Roofing paper.* 1 pc. tar-paper or roofing paper 3′ × 9′.

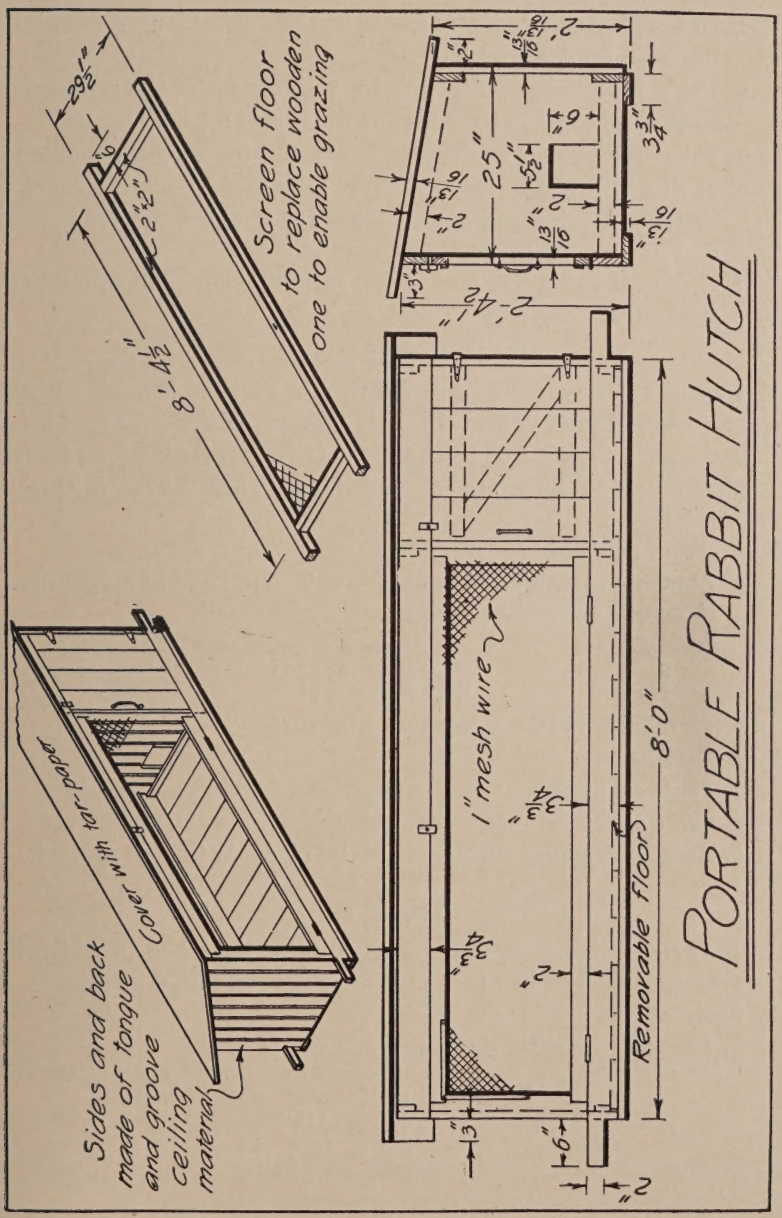


FIG. 185. PORTABLE RABBIT HUTCH

3. *Directions.*
   a. Assemble the ends and the partitions as units.
   b. Make the back and the front.
   c. Assemble the parts.
   d. Nail the roof on.
   e. Assemble the bottom, nailing the floor boards to the cleats but not to the sides or ends.
   f. In hanging the doors, strips of leather may be used for hinges, but steel hinges are best.
   g. Use a fairly large mesh wire for the bottom of the screen floor, so that grass will go through it when it is set on it.
   h. Let roofing paper lie exposed to the sun for several hours before nailing it in place. This tends to minimize buckling. Bend the roofing over the edges, and place tacks along the edges of the roof boards.
   i. A coat of paint will add to the attractiveness and durability of the hutch.

Measuring Box

1. *Purpose.* The measuring box shown in Fig. 186 is made to hold 4 cubic feet of sand or gravel. It is a home-made device that is used in concrete work. The box has no bottom. It is placed on a mixing platform or on the ground and filled up. Then the box is lifted out of the way.
2. *Material required.*
   a. *Lumber.* Any kind of lumber that is sound and of proper dimensions will serve the purpose.

No. of Pieces	Dimensions	Purpose
2	$13/16'' \times 12'' \times 3'$	Sides
2	$13/16'' \times 12'' \times 2'$	Ends

   b. *Hardware.* 16 8d. common wire nails.
3. *Directions.*
   a. Plane all lumber.
   b. Fashion the handles as desired.
   c. Reënforce angler with angle plates or angle irons if desired.

Mixing Box

1. *Purpose.* Mixing boxes serve as a water-tight box in which lime may be slaked or in which mortar or concrete may be mixed.
2. *Material required.*
   a. *Lumber.* Yellow pine, hemlock, fir, etc.

No. of Pieces	Dimensions	Purpose
2	$1'' \times 12'' \times 12'$	Sides
2	$1'' \times 16'' \times 3'\ 10''$	Ends
12	$1'' \times 12'' \times 4'$	Bottom

   b. *Hardware.* 1 lb. 8d. common wire nails.
3. *Directions.*
   a. Joint the bottom boards to have them fit tightly. Use ship-lap

or tongued and grooved lumber if the box is to be used much. A sheet metal bottom is still better.

b. Nail all parts well.

Mixing Platform

1. *Purpose.* Mixing platforms are made in various sizes, and are used in mixing concrete. The platform keeps soil from being mixed with the concrete, and helps to retain the more liquid parts of the concrete mixture.

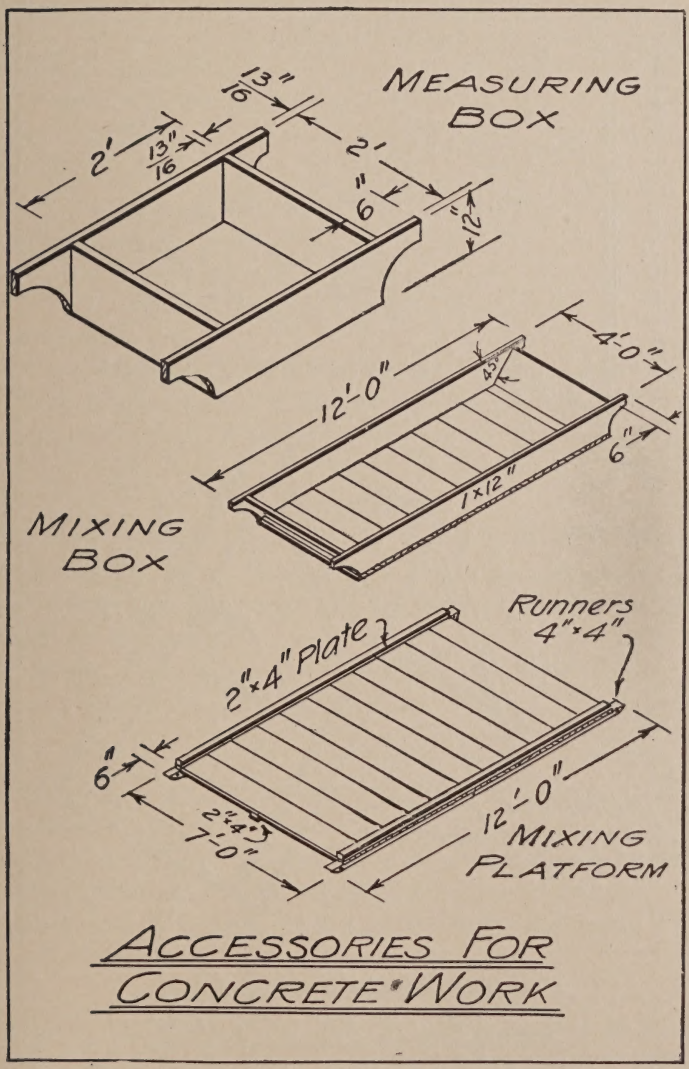


FIG. 186. ACCESSORIES FOR CONCRETE WORK

2. *Material required.*

a. *Lumber.* Sound lumber such as yellow pine, hemlock, fir, etc. is satisfactory.

No. of Pieces	Dimensions	Purpose
2	2″ × 4″ × 11′	Plates
2	4″ × 4″ × 12′	Runners
1	2″ × 4″ × 11′	Runner
100 board feet ship-lap or T & G		Flooring

b. *Hardware.*

1 lb. 8d. common wire nails.

1 lb. 16d. common wire nails.

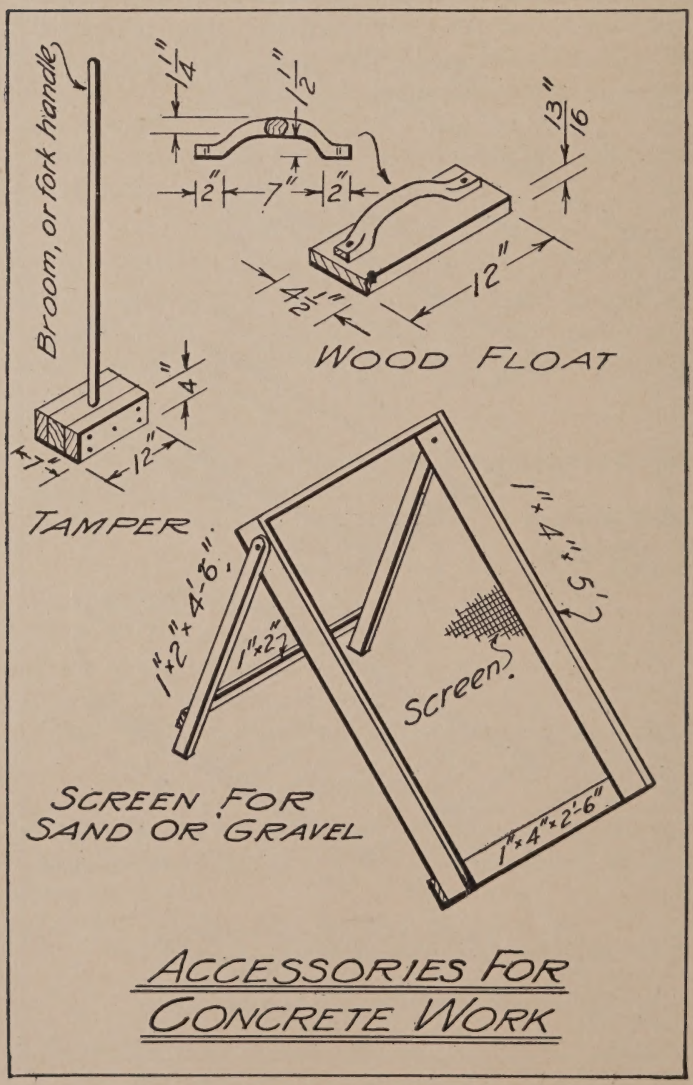


Fig. 187. Accessories for Concrete Work

3. *Directions.*
   a. Simply nail the parts together as shown in the drawing.
   b. Cover knot-holes and other imperfections with patches of sheet iron.
   c. Bore holes near ends of runners so that clevises or rope can be run through them.

Tamper

1. *Purpose.* A tamper is used to ram or tamp concrete so that the larger stones or pebbles are covered with finer material, and also to insure a solid mass of concrete. Tampers can be made in several ways. The one shown is of good weight, and is easy to make.
2. *Material required.*
   a. *Lumber.* Either hard wood or soft wood.

No. of Pieces	Dimensions	Purpose
1	3″ × 4″ × 12″	Base
2	2″ × 4″ × 12″	Base
1 old broom or fork handle		Handle

   b. *Hardware.*
      10 16d. common wire nails.
      10 8d. common wire nails.
3. *Directions.*
   a. The three base blocks are spiked and toe-nailed together.
   b. Bore a hole entirely through the central block for the handle.
   c. Cut a saw-kerf into the lower end of the handle and wedge it fast.

Wood Float

1. *Purpose.* Another home-made tool that is used in cement work is the wooden float. Such a float gives a rougher finish to sidewalks or feeding floors than can be obtained with a steel trowel.
2. *Material required.*
   a. *Lumber.* White pine, basswood or yellow poplar.

No. of Pieces	Dimensions	Purpose
1	$1\frac{3}{16}$″ × $4\frac{1}{2}$″ × 12″	Base
1	$1\frac{1}{8}$″ × $2\frac{3}{4}$″ × 11″	Handle

   b. *Hardware.* 2 1¼″ No. 8 screws, either flat head or round head.
3. *Directions.*
   a. Saw out the handle and finish with a wood file and sandpaper.
   b. Hand-dress the base part so that it is smooth and true.
   c. Screw handle to base. Use a little glue on the joints.

Screen for Sand or Gravel

1. *Purpose.* A screen is used for the double purpose of separating coarse from fine material, and for separating roots or other "foreign" matter from sand or gravel.

2. *Material required.*

a. *Lumber.* Scrap lumber.

No. of Pieces	Dimensions	Purpose
2	1″ × 4″ × 5′	Sides
2	1″ × 4″ × 2′ 6″	Top and bottom
2	1″ × 2″ × 4′ 6″	Legs
1	1″ × 2″ × 2′ 6″	Brace

b. *Hardware.*

¼ lb. ¾″ galvanized wire staples.
2 doz. 8d. finishing nails.
2 ¼″ × 2½″ bolts with washers.
1 pc. ¼″ mesh hardware cloth 3′ 6″ × 5′.

3. *Directions.*

a. The wire netting may, of course, be of any desired mesh. Tack it to the frame with staples.

b. The legs are best fastened to the frame with bolts. If nails have to be used, drill for them as for the bolts, and clinch the ends to keep them from drawing out easily.

c. The wire netting should go above the bottom board, and should be tacked to it.

Concrete Fence Posts

1. *Purpose.* Concrete fence posts are permanent, if properly made. Their construction is not difficult. Farmers as well as large corporations are using them in increasing numbers. On the basis of prewar prices the material for a concrete fence post costs about 25 cents.

2. *Material required for the concrete.* A mixture of 1 part of cement to 3 parts of sand is satisfactory. A quaky mixture, which is wet enough so that it does not need to be tamped, is used.

The reënforcement that is used in posts should be four rods varying from ¼″ to ⅜″ diameter for ordinary posts and four 5/16″ rods

Fig. 188. Concrete Fence Posts on the Farm of L. C. Rinker, Grand Ridge, Ill.

Photograph, courtesy of Portland Cement Association.

for 8″ × 8″ corner posts. These rods may be plain or twisted. They are held together by bands of No. 9 wire as shown in the drawing.

3. *Directions for making posts.*
   a. Place molds in horizontal position.
   b. Place reënforcing in molds so that corner rods are ¾″ from corners of post.
   c. Pour concrete, being careful to work the mixture so that air bubbles will be reduced as much as possible.
   d. Keep the posts out of extreme temperatures, and keep them moist while "curing."
   e. Do not use posts until they are four weeks old.

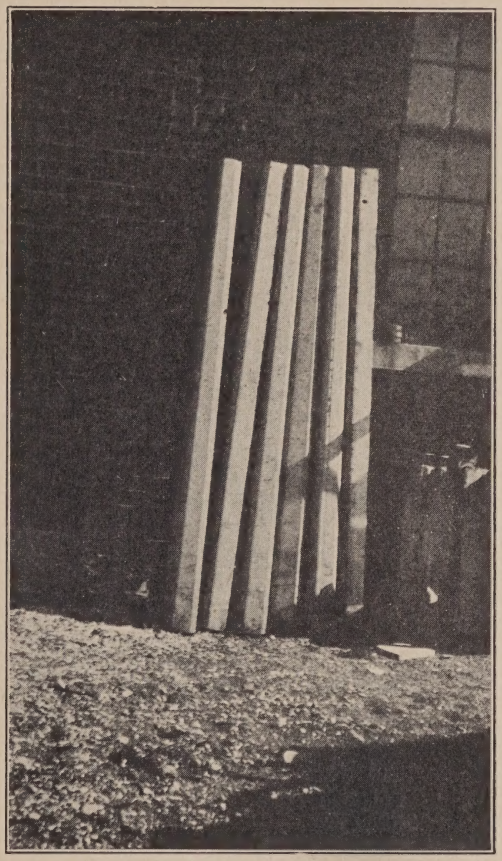


FIG. 189. CONCRETE FENCE POSTS MADE AT THE SCHOOL OF AGRICULTURE, OHIO STATE UNIVERSITY
Photograph, courtesy of Portland Cement Association.

4. *Material required for mold.* The following material is required for a six-post gang mold:
   a. *Lumber.* White pine, yellow pine, fir, cypress, etc.

No. of Pieces	Dimensions	Purpose
6	13/16″ × 7¾″ × 8′ ship-lap	Flooring
3	2″ × 4″ × 3′ 6″	Sills
4	13/16″ × 5¾″ × 3′ 6″	End boards
7	13/16″ × 5¾″ × 7′ 2″	Sides

   b. *Hardware*
      ½ lb. 6d. common wire nails.
      ¼ lb. 6d. finishing nails.
      4 6″ strap hinges with screws.
      4 2½″ or 3″ screw eyes and hooks.
5. *Directions for making mold.*
   a. This mold is built so that the posts are 5¾″ thick from base to

top one way, and taper from 6″ to 4″ the other way. If posts are wanted that taper upward on all four sides the mold is arranged with all the butt ends of the post on one end of the mold instead of alternating as in this one, and then the side piece must be tapered.

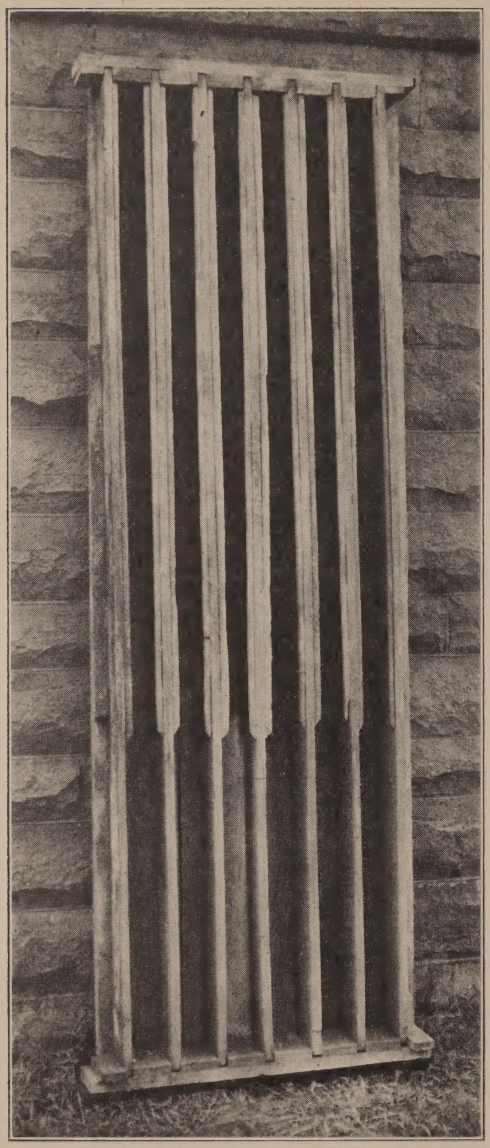


FIG. 190. A GANG MOLD FOR CONCRETE FENCE POSTS

Made at the Galesburg, Illinois, High School. The strips on the sides and on the partitions make chamfered corners on the posts. Photograph, courtesy of Portland Cement Association.

b. The end pieces are made so that they can be folded back, thus making it easier to draw out the partition or side boards.

c. Nail several little angle blocks to the floor so that they will prevent the outside side boards from spreading.

d. All lumber should be planed smooth, and should be given several coats of boiled linseed oil. This will keep the lumber from warping and makes it easier to get a smooth surface on the fence posts.

e. Chamfered corners are made on fence posts by fastening three-cornered strips to the sides or partitions as shown in Fig. 190.

Forms for Concrete Foundations

1. *Purpose.* Concrete foundations for farm structures are usually placed in position by means of forms. Typical construction is

shown in Fig. 192. This figure also shows that the earth may sometimes be used to take the place of a wooden form. This is particularly true of foundations built in trenches.

2. *Material required.* Forms should be water-tight. Ship-lap is good for the purpose, common unmatched lumber is also used.
3. *Directions.*
   a. It is impossible to give general directions that will apply in all cases. The fundamental principle involved is to build the forms water-tight, and so that they cannot bulge.

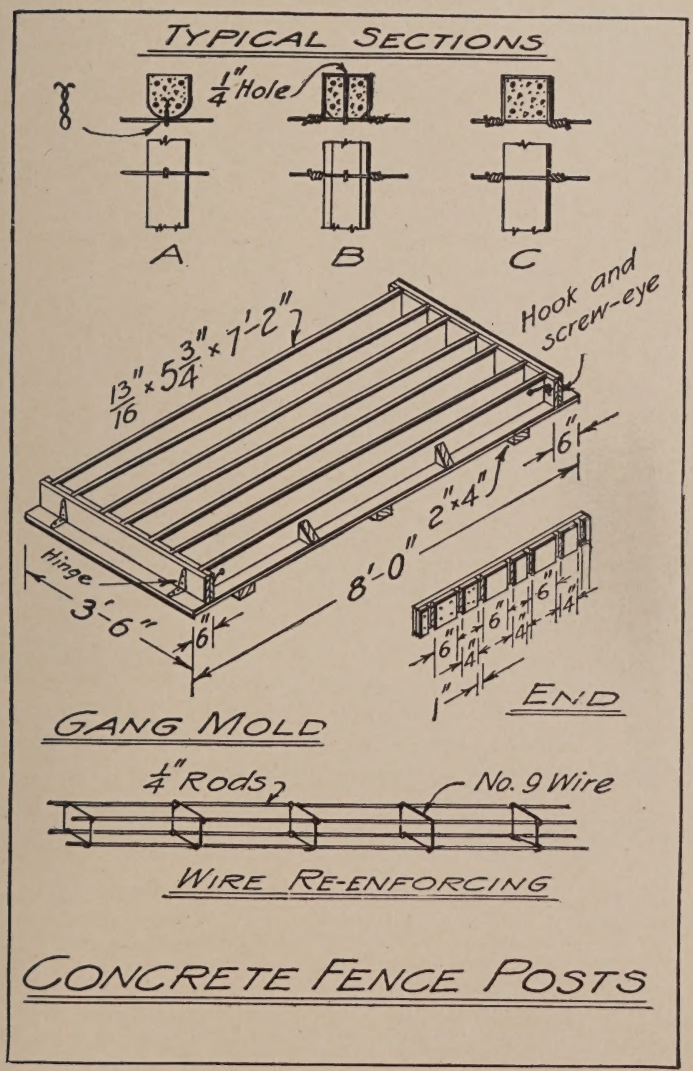


FIG. 191. CONCRETE FENCE POSTS

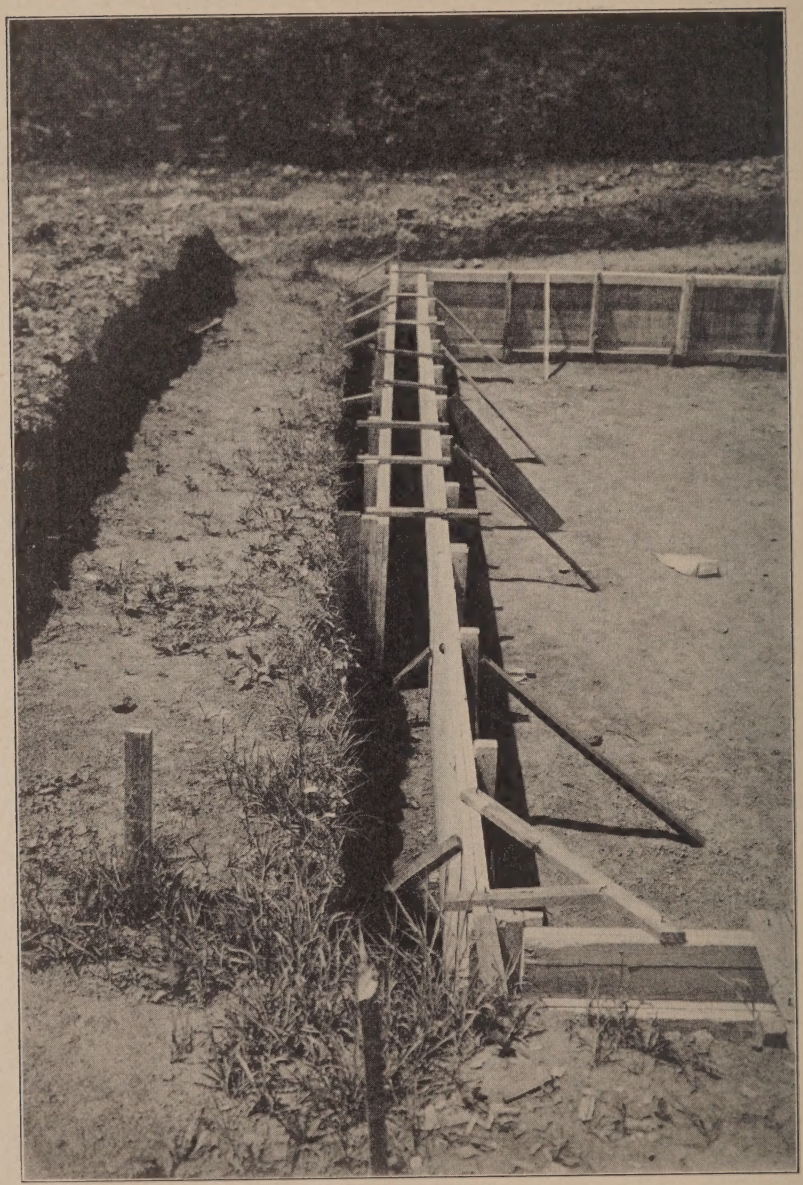


FIG. 192. FORMS IN PLACE FOR A CONCRETE FOUNDATION

Notice the method of construction and of bracing. Photograph, courtesy of Portland Cement Association.

b. Ordinary baling wire is often used to tie together the opposite sides of forms. The concrete may be poured around the wire. The latter is then cut off flush with the concrete when forms are removed.

c. Unless the forms are large 2″ × 4″ lumber is used as stays to keep the forms from bulging. These are fastened together edgewise thus affording maximum resistance to bending.

TABLE 14. MATERIAL REQUIRED FOR FENCE POSTS

DIMENSIONS			FOR TEN POSTS 1 PART CEMENT; 3 PARTS SAND		REËNFORCING REQUIRED
Length	Top	Bottom	Sacks cement	Cu. ft. sand	
7′	3″ × 4″	5″ × 4″	2.8	8.5	4 ¼″ round rods
7′	4″ × 4″	5″ × 5″	3.5	10.6	4 5/16″ round rods
7′	5″ × 5″	6″ × 6″	5.3	15.8	4 ⅜″ round rods

TABLE 15. QUANTITY OF WIRE FENCING REQUIRED FOR FIELDS OF CERTAIN SIZES

For rectangular fields				*For square fields*				
ACRES	LENGTH OF FIELD	WIDTH OF FIELD	LENGTH OF FENCE REQUIRED	ACRES	LENGTH OF SIDE OF SQUARE		LENGTH OF FENCE REQUIRED	
	Feet	Feet	Feet		Feet	Inches	Feet	Inches
1	264	165	858	1	208	9	835	..
1	330	132	924	2	295	2	1180	8
1¼	330	165	990	2½	330	..	1320	..
2½	660	165	1650	3	361	6	1446	..
4	528	330	1716	4	417	5	1669	8
5	660	330	1980	5	466	8	1866	8
6	990	264	2508	6	511	3	2045	..
7	1320	231	3102	7	552	2	2208	8
8	1320	264	3168	8	590	4	2361	4
9	1320	297	3234	9	626	2	2504	8
10	825	528	2706	10	660	..	2640	..
15	1320	495	3630	20	933	5	3733	8
20	1650	528	4356	25	1043	7	4174	..
25	1320	825	4290	30	1143	2	4572	8
30	1320	990	4620	40	1320	..	5280	..
40	1650	1056	5412	50	1475	10	5903	4
50	1650	1320	5940	60	1616	8	6466	8
60	1980	1320	6600	70	1746	2	6984	8
70	2640	1155	7590	75	1807	6	7230	..
80	2112	1650	7524	80	1866	9	7467	..
100	2640	1650	8580	100	2087	1	8348	4
120	3168	1650	9636	120	2286	4	9145	4
140	4620	1320	11880	140	2469	6	9878	..
160	5280	1320	13200	160	2640	..	10560	..
320	5610	2112	15444	320	3733	7	14934	4
640	5610	4224	19668	640	5280	..	21120	..

Dimensions given are exact, so that in buying fence, sufficient allowance should be made to cover fence taken up in wrapping around end and corner posts.

For rectangular or oblong fields with square corners, twice the length of one short side added to twice the length of one long side, with addition for wrapping around posts, will give total approximate length of fence under conditions stated above.

For square fields four times the length of one side, with at least three feet added for wrapping around each corner, end or gate post will give the approximate length of fence required if stretched properly.

Concrete Sidewalk

1. *Purpose.* Permanent sidewalks are most commonly built of concrete. The various stages in sidewalk construction are well shown in Fig. 193. The work is essentially the same as building feeding floors of concrete which is described elsewhere in this book.
2. *Material required.* Use a 1:2:3 mixture as explained under "Feeding Floors" for one course work. The slab should be 4″ thick. For two course construction use a 1:2:5 mixture for the first course and finish with a mixture of 1 part of cement to 2 parts of sand for the second coat.
3. *Directions.*
   a. In most soils where the ground freezes to any extent it is advisable to place a sub-base of cinders, broken stone, or other porous material of that sort, under the concrete walk. The purpose of the sub-base is to assure good drainage, as water might otherwise accumulate under the walk with the result that the walk might be broken. A sub-base 12″ thick is ample in most places. In some sections of the United States, particularly in sandy soils and in sections not visited by heavy frosts it is not necessary to use a sub-base.
   b. When sidewalks are built without a curb 2″ × 4″ scantlings are used for forms. If a curb is to be built continuous with the walk and flush with its top an 8″ or 10″ plank serves as a form on the gutter side and a 2″ × 4″ on the opposite side.
   c. These forms should be staked down so that they cannot bulge, and so that the outer form is 1″ lower than the inner one. This gives enough pitch outward to shed water properly.
   d. Provide for expansion joints by laying off rectangles or squares from 3′ to 6′ long. If the walk is to be a two course job put strips of tar or of felt paper after each block or rectangle when the first course is laid, and mark the location on the side forms so that the top coat may be cut through with a groover directly above the lower expansion joints.
   e. In case the sidewalk is to be one-course construction, expansion joints are also used. They are put in 20′ to 50′ apart by placing a greased board across the walk where the joint is to be. The concrete is poured against one side of the board only. The board is withdrawn when the next block is poured, several thicknesses of felt paper or other compressible material being placed where the board was before the adjoining block is laid. Joints are cut with a groover at distances not over six feet apart, as in two-course construction. A straight edge is used for a guide in this operation.
   f. To level up the top surface use a straight edge as shown in Fig.

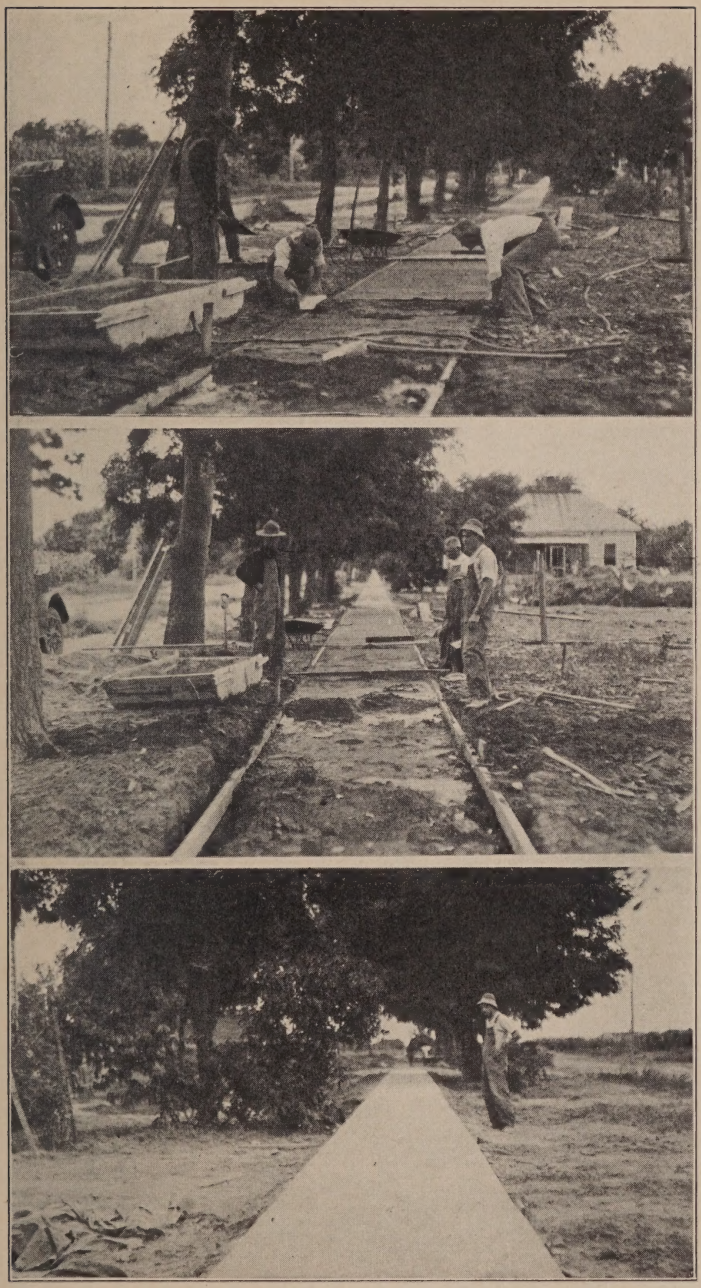


FIG. 193. HOME PROJECT OF HARRY LEE, GARDEN CITY, KANSAS

With the help of his teacher he built 1350 square feet of sidewalk. He hired some help to mix and handle the concrete. Photograph, courtesy of Wm. R. Curry, Topeka, Kansas.

FIG. 194. MACHINE SHED

Designed and built by students at the La Crosse County School of Agriculture and Domestic Economy, Onalaska, Wis. The shed is 24 feet wide and 42 feet long. The concrete mixer shown in the foreground was made by students. The castings for the mixer were purchased from a supply house.

193. The straight edge is pushed forward and crosswise in a zigzag fashion over the top edges of the forms.

g. The surface is finished with a steel trowel and sand floated with a wooden float as shown in Fig. 187, if a somewhat rough finish is desired.

h. The walk should be protected against extreme temperatures while "curing." In the summer cover the top with paper, straw, or soil, and keep it damp. Do not use the walk heavily for three weeks.

i. Persons with relatively little experience in sidewalk construction are likely to get best results by using the one-course type of construction. The amount of material required is shown in Table 16.

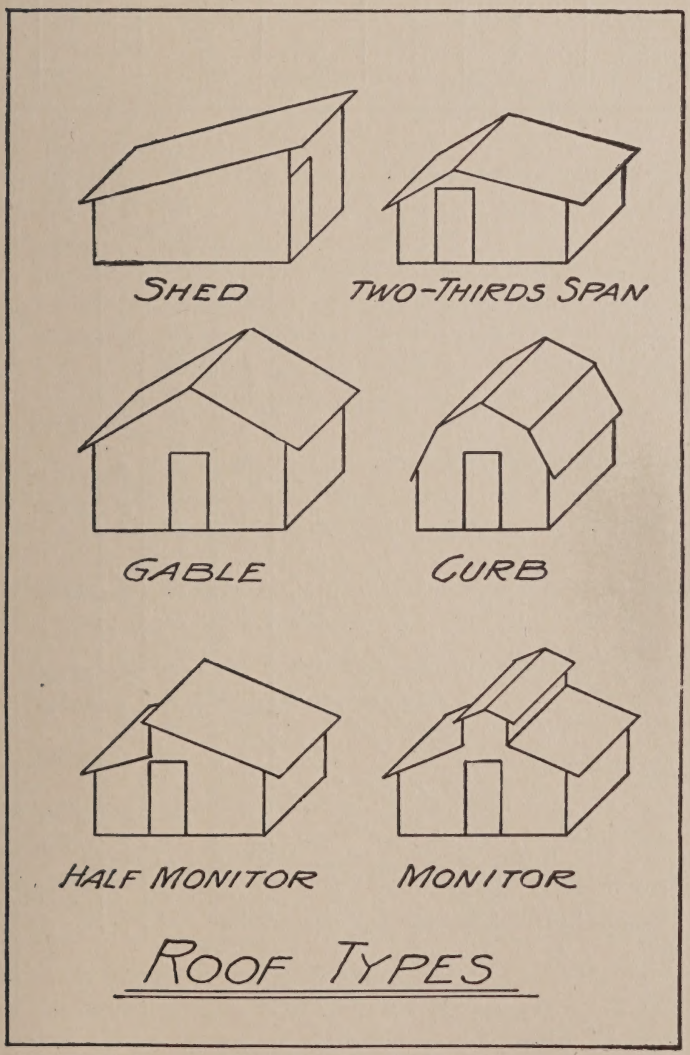


FIG. 195. ROOF TYPES

TABLE 16. QUANTITIES OF MORTAR AND OF CONCRETE MADE FROM ONE SACK OF CEMENT AND VARYING AMOUNTS OF SAND AND STONE

	MIXTURE		MATERIALS			RESULTING VOLUME IN CUBIC FEET	
Cement	Sand	Pebbles or Stones	Cement (sacks)	Sand (cu. ft.)	Pebbles or Stones (cu. ft.)	Mortar (cu. ft.)	Concrete (cu. ft.)
1	1.5		1	1.5		1.75	
1	2		1	2		2.1	
1	3		1	3		2.8	
1	1.5	3	1	1.5	3		3.5
1	2	3	1	2	3		3.9
1	2	4	1	2	4		4.5
1	2.5	4	1	2.5	5		4.8
1	2.5	5	1	2.5	5		5.4
1	3	5	1	3	5		5.8

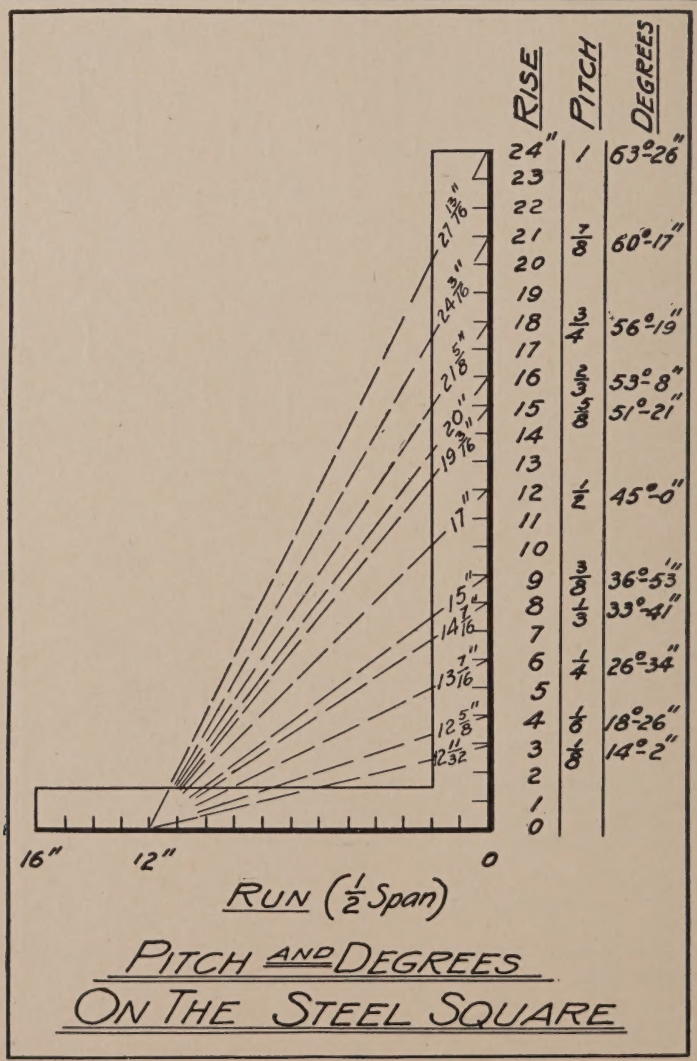


FIG. 196. PITCH AND DEGREES ON THE STEEL SQUARE

Roof Framing

Roof types. A number of types of roofs that are used on farm structures are shown in Fig. 195. If the principles governing the laying out of common rafters is understood it will be possible to frame any of these roof types, as they involve only modifications of common rafter construction.

Framing common rafters. If the rise and the span of a building is known it is possible to figure out the length of the common rafters required by arithmetic. This, however, is not the way it is done in actual practice. The first thing to determine is the pitch. This is the ratio of the rise to the span (Fig. 197), and is usually ¼, ⅓, or ½. Fig. 196 shows that a rise of 6″ in 12″ is called a ¼ pitch, and a rise of 12″ in 12″ is called a "half-pitch." This is true because the pitch is equal to the rise divided by the span.

The half-span is called the "run." In laying off rafters the constant of run is taken as 12″, and on the tongue of the square. The rise per foot of run is taken along the blade, as in Fig. 197.

One practical way to get the length of a common rafter is to apply the square along the edge of a rafter as many times as there are feet in the half-span, using the proper rise with the constant 12″ of run as shown in Fig. 197. The length of the tail is added to the rafter length, and the rafter length is shortened at the ridge by half the thickness of the ridge board if one is used.

The length of common rafters for varying pitches per foot of run can be taken from Fig. 196. For example, what is the length per foot of run for a rafter having a pitch, or a rise of 12″ in a run of 12″? The answer 17″ is given on the diagonal line.

The length of common rafters may also be taken from the framing square or from the following table:

TABLE 17. LENGTH OF COMMON RAFTERS
(For Gable Roofs)

Rise (inches per ft.)	Width of Building in Feet									
	10	12	14	16	18	20	22	24	26	28
4	5′3¼″	6′3⅞″	7′4½″	8′5 2/12″	9′5 10/12″	10′6½″	11′7⅛″	12′7¾″	13′8 5/12″	14′9½″
6	5′7 1/12″	6′8½″	7′8 11/12″	8′11 1/12″	10′3¼″	11′2 2/12″	12′8 10/12″	13′10 8/12″	14′6 5/12″	15′7 10/12″
8	6′½″	7′2½″	8′4 11/12″	9′7⅜″	10′9 10/12″	12′¼″	13′2⅝″	14′5 1/12″	15′7½″	16′9 11/12″
10	6′6⅛″	7′9¾″	9′1 4/12″	10′4 11/12″	11′8 7/12″	13′1¼″	14′8 10/12″	15′7 5/12″	16′11½″	18′2 8/12″
12	7′7⅞″	8′5 10/12″	9′10¾″	11′3¾″	12′8¾″	14′8 11/12″	15′8 8/12″	16′11¾″	18′4⅝″	19′9 7/12″

To find the length of a common rafter, look in the table at the intersection of the column representing the width or span of the building, with the column representing the rise in inches per foot of the roof: for example, What is the length of a common rafter for a building 14′ wide, having a roof sloping 8 inches per foot? Ans.: 8′ 4 11/12″. The tail or

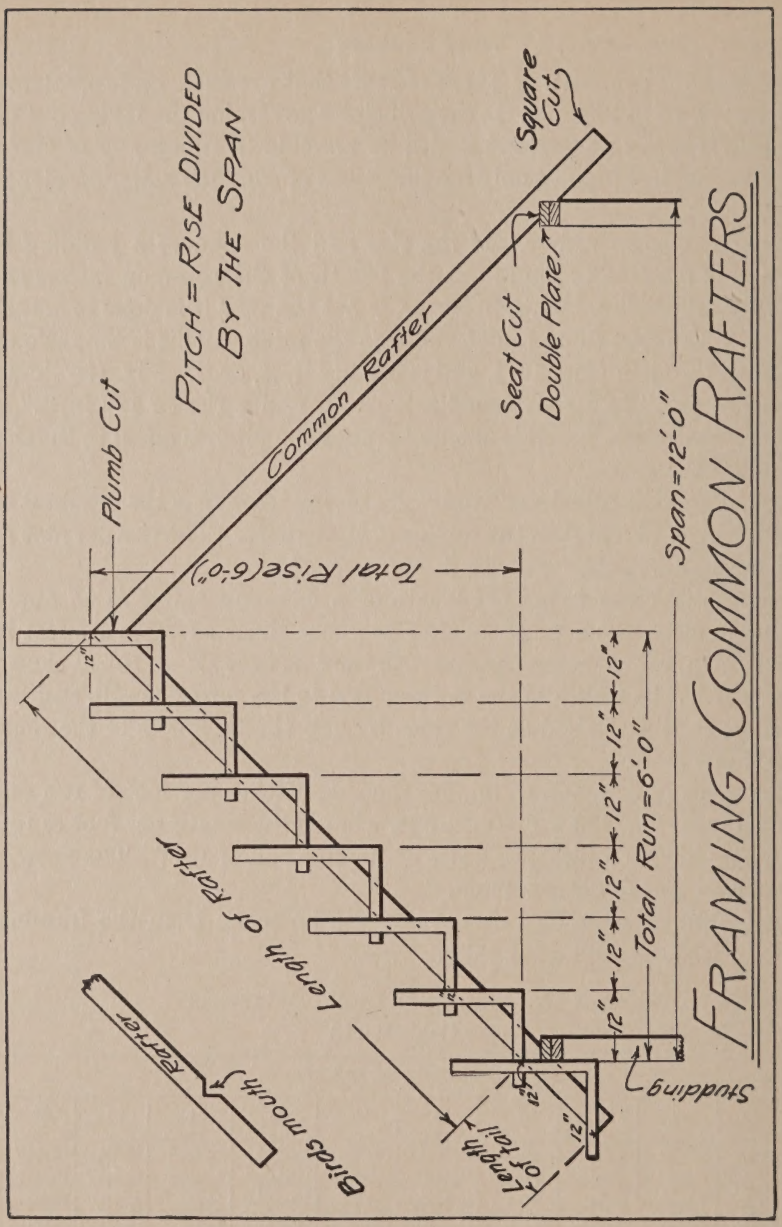


Fig. 197. Framing Common Rafters

length of rafter beyond the side of the building must be added to the dimensions given in the table to give the over-all length of the rafter.

Suggestions. Select a straight piece of rafter material for the pattern. Cut one pair of rafters, and try them out to see if they fit perfectly. Lay off all rafters so that the crowned or convex edges will be upward when the rafters are nailed in position.

An easy way to "raise" rafters for a gable roof is to toe-nail them at the apex before they are swung up into their final position; two men are required for this method, each standing where the rafters are to be nailed to the plates.

REFERENCES

1. *Relating to uses of the steel square.*
Fair, Albert. *The Steel Square as a Calculating Machine.* Industrial Publishing Co.
Griffith, Ira Samuel. *Carpentry.* Manual Arts Press.
Hodgson, Frederick Thomas. *The Carpenter's Steel Square and its Uses.* (2 vols.) Frederick J. Drake Co.
Hodgson, Frederick Thomas. *Modern Carpentry.* (2 vols.) Frederick J. Drake Co.
Radford, Wm. *Details of Building Construction.* Radford Architectural Co., Chicago.
Radford, Wm. *Modern Carpentry.* (2 vols.) Radford Architectural Co., Chicago.
Stoddard, Dwight Lincoln. *Steel Square Pocket Book.* Industrial Publishing Co.
2. *Free bulletins and circulars.*
Raising Belgian Hares and Other Rabbits. Lantz, David E. Farmers' Bulletin No. 496.
Cement and its Uses on the Farm. Crane, E. C. Bulletin No. 52, 1917, University of Minnesota, Minneapolis. Price $.25.
Concrete Fence Posts. Portland Cement Association.
Concrete Troughs, Tanks, and Cisterns. Portland Cement Association.
The Use of Concrete on the Farm. Prepared by Office of Public Roads, Farmers' Bulletin No. 461.
3. *Text or reference books.*
Baxter, Leon H. *Elementary Concrete Construction.* The Bruce Publishing Co.
Brace, George M., and Mayne, D. D. *Farm Shop Work.* American Book Co.
Blackburn, Samuel A. *Problems in Farm Woodwork.* Manual Arts Press.
Campbell, H. Colvin, and Beyer, Walter F. *Practical Concrete Work for the School and Home.* The Prang Co., Chicago.
French, Thos. E., and Ives, Frederick W. *Agricultural Drawing.* McGraw-Hill Book Co.
Gibson, C. F. *Breeding and Care of Rabbits.* Goodspeed Press, Chicago.
Keene, E. S. *Mechanics of the Household.* McGraw-Hill Book Co.
Ramsower, Harry C. *Equipment for the Farm and the Farmstead.* Ginn & Co.
Roehl, Louis M. *Agricultural Woodworking.* Bruce Publishing Co.
Roehl, Louis M. *Farm Woodwork.* Bruce Publishing Co.

CHAPTER XV

RELATING TO THE FARM HOME

THE projects given in this chapter deal with repair and construction work related to the farm home. It is often possible to arrange shelves, here and there, or to make objects such as a home-made fireless cooker, that will add to the comforts and conveniences of the home. There is considerable satisfaction in using objects that have been constructed by members of the family.

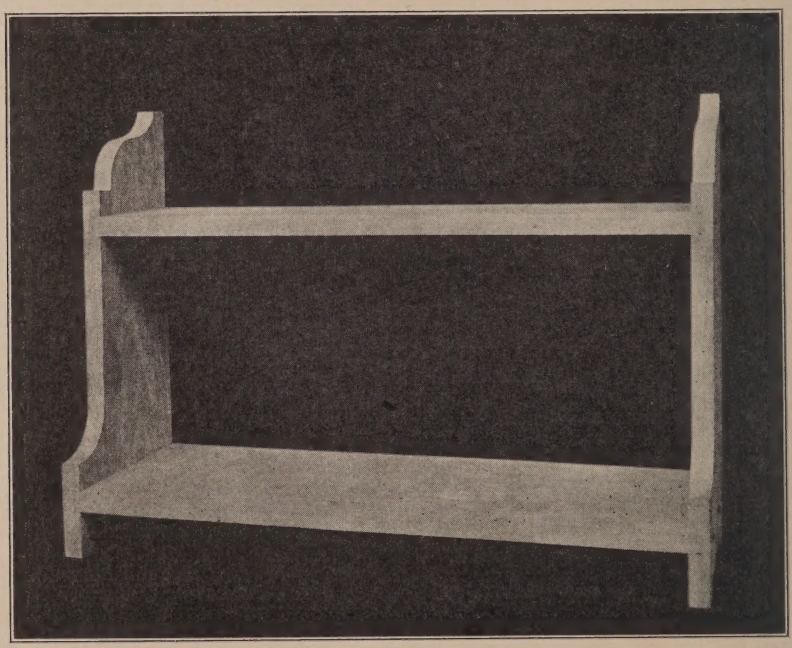


FIG. 198. STANDING SHELF, OR BOOK RACK

Standing Shelf, or Book Rack

1. *Purpose.* A simple little standing shelf, or book rack, such as the one shown in Fig. 199, is easy to make and quite useful. The design may be varied to suit one's taste and the tools at one's disposal.
2. *Material required.*

a. *Lumber.* Oak, chestnut, fir, cypress, etc.

No. OF PIECES	DIMENSIONS	PURPOSE
2	$^{13}/_{16}'' \times 7\frac{3}{4}'' \times 17''$	Ends
1	$^{13}/_{16}'' \times 5\frac{3}{4}'' \times 26\frac{7}{8}''$	Top shelf
1	$^{13}/_{16}'' \times 7\frac{3}{4}'' \times 26\frac{7}{8}''$	Lower shelf

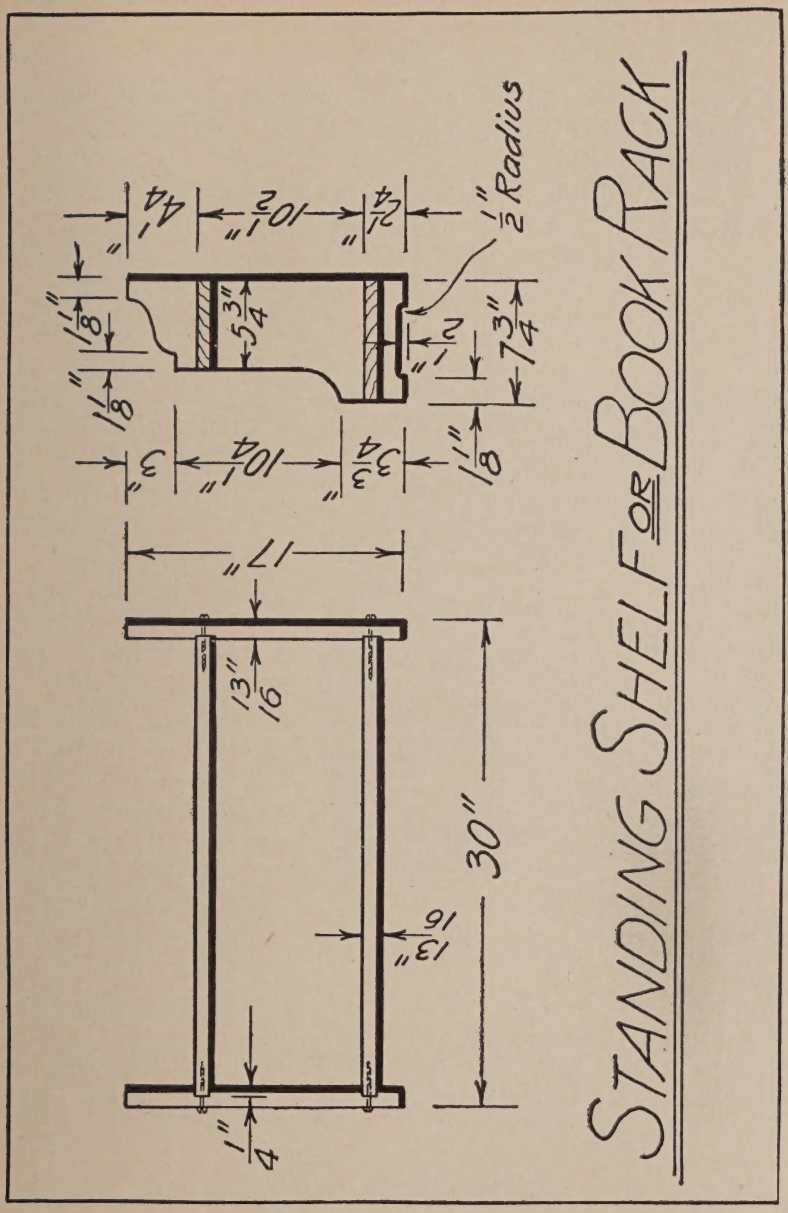


Fig. 199. Standing Shelf, or Book Rack

b. *Hardware.* 8 3″ No. 8 round-head blued screws.

3. *Directions.*

a. Hand-dress all pieces.

b. Dado shelves ¼″ into the ends.

c. The curves are worked out with a keyhole saw and cabinet rasp, or half-round file if a bracket saw is not available.

d. Finish with shellac or varnish.

Sawbuck

1. *Purpose.* The sawbuck has been used for generations wherever cordwood is cut into short lengths.
2. *Material required.*
   a. *Lumber.* Either hard or soft wood is satisfactory.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 36''$	Legs
1	$1\frac{3}{4}'' \times 3\frac{3}{4}'' \times 24\frac{1}{2}''$	Cross-tie
2	$1\frac{3}{16}'' \times 3\frac{1}{2}'' \times 28''$	Cross-tie

   b. *Hardware.* 8 6d. nails or $1\frac{3}{4}''$ No. 8 flat-head screws.

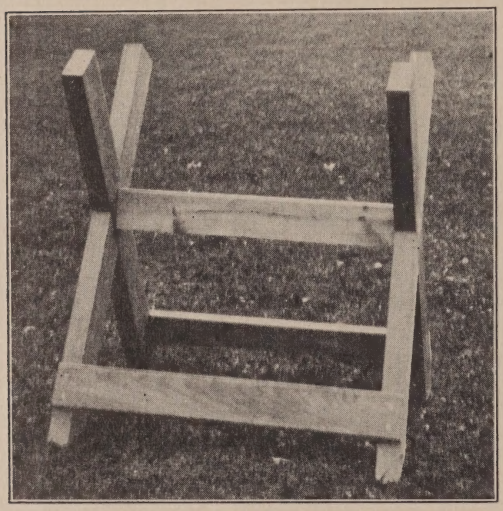


Fig. 200. Sawbuck

Built by students under the direction of Mr. W. G. Hall, at the Pennsylvania State College.

3. *Directions.*
   a. The method of cutting the bevels on the legs is shown in the drawing, as is also the method of wedging the ends of the cross-tie.
   b. The legs are held together by means of half-lap joints. These joints should fit snugly. To get them right first plane the legs smooth and true, then lay them across each other in the position they are to have. Scribe along the sides of the upper piece with knife. Halve out one member. Next lay this on top of the remaining member, scribe as before and halve out to proper depth.
   c. In making half-lap joints, particularly at angles as called for, beginners frequently cut away too much material, thus making a loose joint.

Flower Box "A"

1. *Purpose.* This box is of the simplest construction, but of desirable proportions. The length may vary considerably.
2. *Material required.*
   a. *Lumber.* Cedar, cypress, or white pine.

No. of Pieces	Dimensions	Purpose
1	$1\frac{3}{16}'' \times 9\frac{3}{4}'' \times 3'$	Bottom
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 3'$	Sides
2	$1\frac{3}{16}'' \times 5\frac{3}{4}'' \times 8\frac{1}{8}''$	Ends

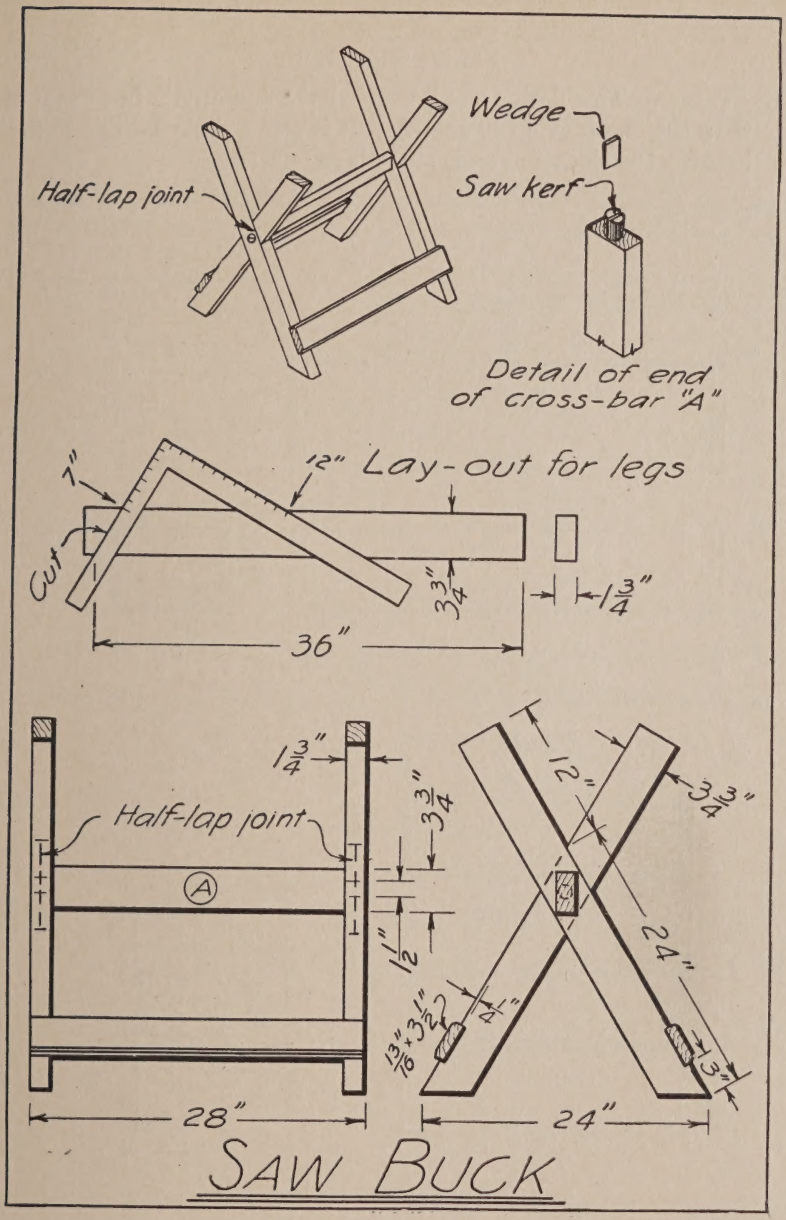


FIG. 201. SAWBUCK

b. *Hardware.* ¼ lb. 6d. finishing nails.

c. *Paint.* A small quantity of good quality.

3. *Directions.*

a. Hand-dress all pieces, and nail or screw them together.

b. Drill 2 ¼″ holes in bottom for drainage.

c. Finish with stain and waterproof varnish or paint.

Flower Box "B"

1. *Purpose.* This flower box is somewhat more ornate in appearance than the one previously shown. It is also a little harder to make because the sides and ends are splayed outward.

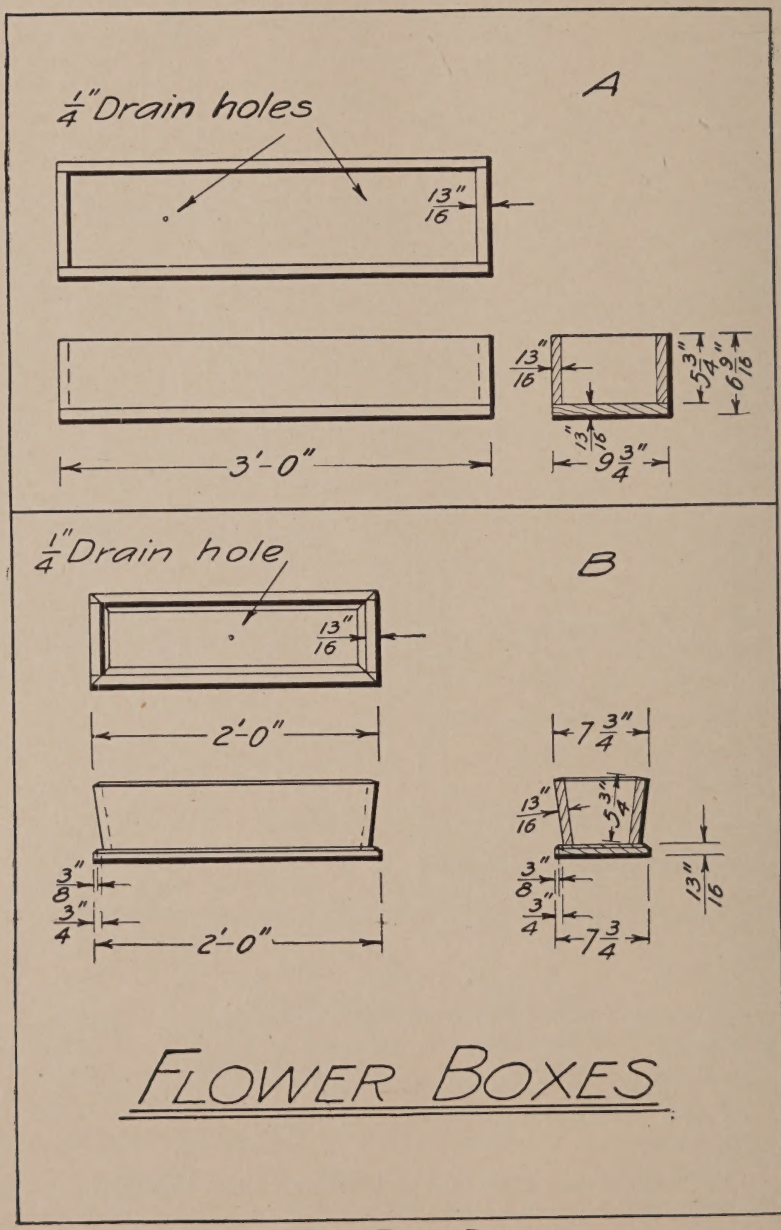


FIG. 202. FLOWER BOXES

2. *Material required.*

a. *Lumber.* Cedar, cypress, or white pine.

No. of Pieces	Dimensions	Purpose
1	$^{13}/_{16}'' \times 7\frac{3}{4}'' \times 2'$	Bottom
2	$^{13}/_{16}'' \times 5\frac{3}{4}'' \times 2'$	Sides
2	$^{13}/_{16}'' \times 5\frac{3}{4}'' \times 6\frac{1}{8}''$	Ends

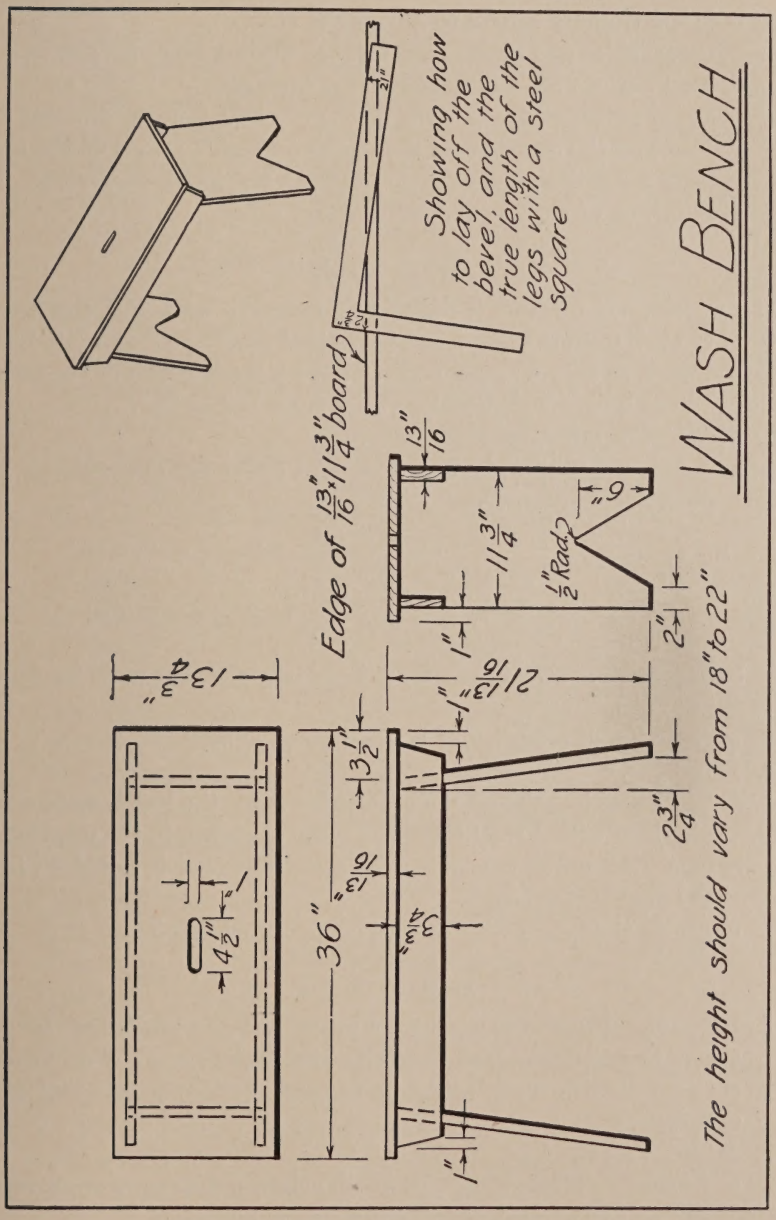


Fig. 203. Wash Bench

b. *Hardware.*
1 doz. 1¾″ No. 8 screws (either flat- or round-head).
1½ doz. 8d. common wire nails.

c. *Paint.* A small quantity of good quality.

3. *Directions.*
a. Hand-dress all lumber.
b. Use a framing square to lay off the cuts.
c. Screw sides and ends together, first drilling holes for screws.
d. Nail bottom on, and drill hole for drainage.
e. Some persons like to tack pieces of sheet-iron or tin over the joints on the outer or on the upper corners, to prevent the sides from spreading, due to moisture from the inside of the box.
f. Paint, or varnish as desired.

Wash Bench

1. *Purpose.* If washing is done in an ordinary wash-tub, the height of the tub from the floor is an important factor. One way to make the work as easy as possible is to have a wash bench of the height one likes best. This usually varies from 18″ to 22″.

2. *Material required.*
a. *Lumber.* White pine, cypress, and cedar are desirable for the purpose.

No. of Pieces	Dimensions	Purpose
1	$\frac{13}{16}$″ × 13¾″ × 36″	Top
2	$\frac{13}{16}$″ × 11¾″ × 21¼″	Legs
2	$\frac{13}{16}$″ × 3¾″ × 34″	Sides

b. *Hardware.* 16 1¾″ No. 8 flat-head bright screws or 20 8d. finishing nails.
c. *Oil.* Small quantity of boiled linseed oil.

3. *Directions.*
a. The exact length and the correct bevel for the legs is most easily obtained with a steel framing square as shown in the drawing.
b. The "V" notch is begun from a ½″ hole that is bored 6″ from the ends of the legs.
c. Finish the bench with several coats of linseed oil.

Fireless Cooker

1. *Purpose.* Fireless cookers are a convenience in any home, but the cost of the manufactured ones is prohibitive to many. The drawing shown herewith represents a home-made fireless cooker that gives satisfaction.

2. *Material required.*
a. *Lumber.* White pine, basswood, yellow poplar, and other woods can be used. Non-resinous woods are best.

No. of Pieces	Dimensions	Purpose
1	$13/16'' \times 19\frac{5}{8}'' \times 19\frac{5}{8}''$	Top
1	$13/16'' \times 18'' \times 18''$	Bottom
2	$13/16'' \times 18'' \times 19\frac{1}{8}''$	Front and back
2	$13/16'' \times 16\frac{3}{8}'' \times 19\frac{1}{8}''$	Sides
4	$13/16'' \times 2\frac{1}{2}'' \times 19\frac{5}{8}''$	Lower trim
4	$13/16'' \times 1\frac{1}{8}'' \times 19\frac{5}{8}''$	Upper trim
3	$13/16'' \times \frac{5}{8}'' \times 19\frac{5}{8}''$	Beads on cover

b. *Hardware.*

1 galvanized iron pot 8½″ diameter, and 11¼″ deep, with lid, and apron 17 3/16″ square as per drawing.

¼ lb. 6d. finishing nails.

¼ lb. 8d. finishing nails.

1 ordinary sash lock with screws.

3 handles or pulls, with screws.

1 pair 2″ × 2″ butt hinges with screws.

4 ball-bearing casters.

Aluminum pots and soapstone to suit. (These can be purchased separately from dealers handling the fireless cookers.)

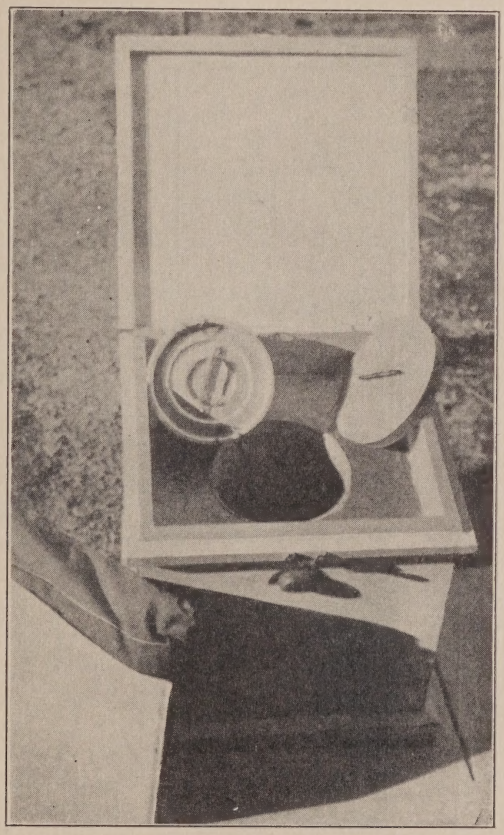


Fig. 204. Fireless Cooker with Cover open, showing one of the Pots and the Galvanized Iron Lid

A sheet of asbestos covered with muslin, and a cushion stuffed with packing material is shown in part standing up against the left front corner of the cooker.

c. *Packing.* The cushion that goes over the pots, and the packing otherwise used may consist of crumpled newspaper, ground cork, or other insulating material. Crumpled newspaper is satisfactory, though perhaps not as good as ground cork.

Several sheets of asbestos paper are covered with muslin, and are used directly above the pots. The sheets should be 17 3/16″ square.

d. *Paint.* Several coats of white paint, either in a dull or a glossy

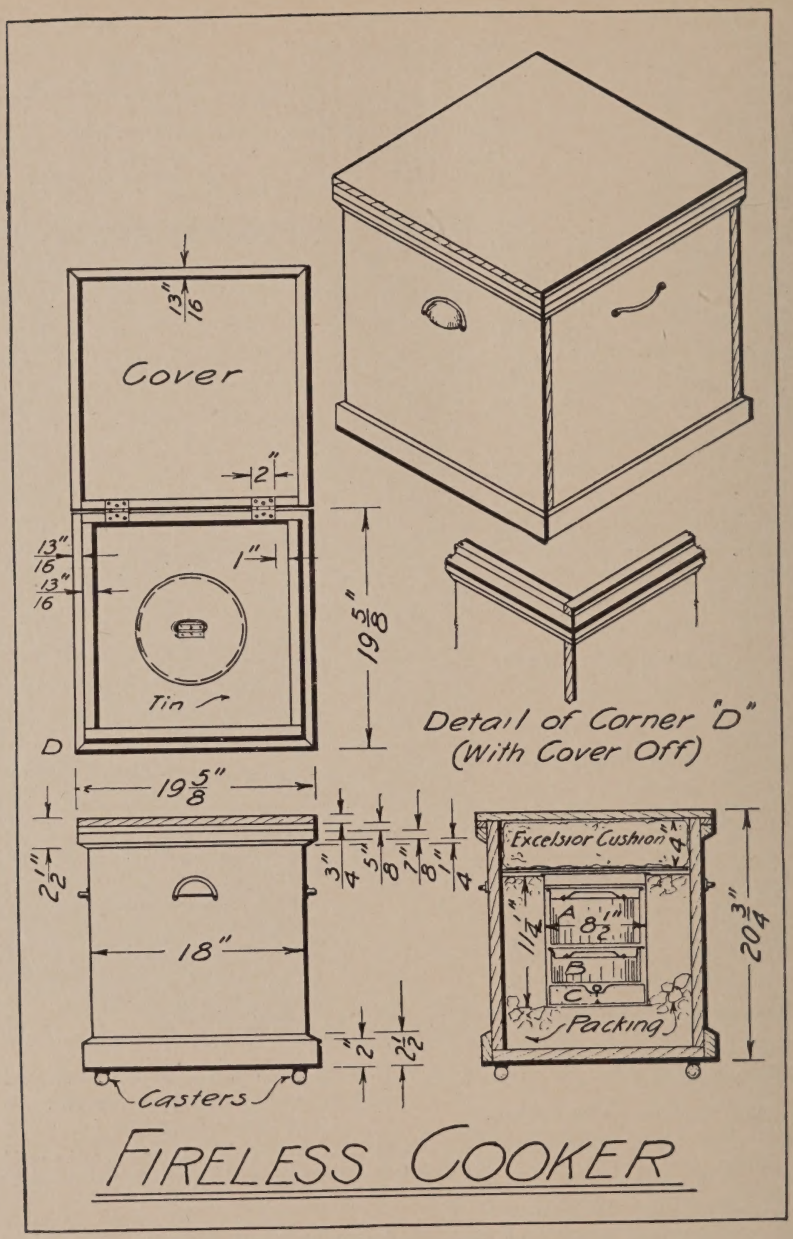


FIG. 205. FIRELESS COOKER

finish should be applied on the outside of the cooker, on the inside of the lid, and on that portion of the cooker that is visible when the cushion is removed.

3. *Directions.*

a. If boards cannot be secured that are as wide as the dimensions specified, glue up narrower stock.

b. To glue up boards, joint the edges carefully, but do not plane the sides until after the glue has set. All irregularities can then be smoothed up at once.

c. The cooker may be nailed or screwed together. If nails are used, set them and putty the holes after the priming coat has been applied.

d. The cooker can be made in two or more units, depending upon requirements.

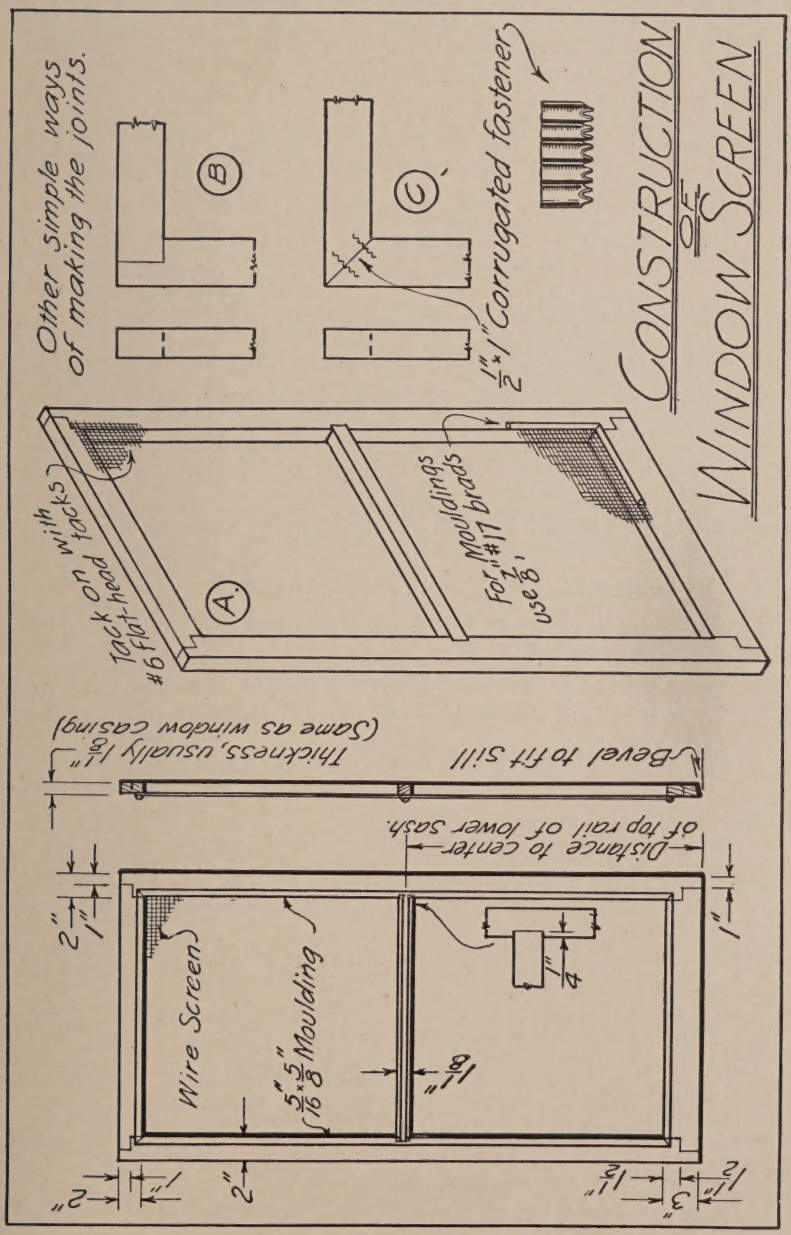


FIG. 206. CONSTRUCTION OF WINDOW SCREEN

Window Screens

1. *Purpose.* Farmers frequently need to repair and to make window screens. Sometimes pieces of netting are tacked directly to window casings, which disfigures the latter, and the screening soon rusts or rots if left up the year round. It is much better, and in the end cheaper, to have removable screens that can be placed easily, and that may be stored away during the winter season. Several simple methods of construction are shown, such as may be used to advantage by farmers and others having but a limited number of tools with which to do such work.
2. *Material required.*
   a. *Lumber.* White pine, fir, cypress, or cedar. The material needs to be as thick as the window casings. This is usually $^{13}/_{16}''$ or $1\frac{1}{8}''$. Use lumber 2″ wide for the top and sides and 3″ wide for the bottom piece. Cross-bars may be made from $\frac{3}{4}''$ to $1\frac{1}{8}''$ wide.
   Molding to fasten down the netting may be purchased or can be made out of laths.
   b. *Hardware.* Wire netting is made in black and galvanized wire, and in copper and brass. Galvanized wire netting is moderately priced, and lasts well. Number 6 flat-head tacks are used to tack the netting to the frame.
   c. *Paint.*
3. *Directions.*
   a. The joints may be made in a number of ways as shown in the drawing.
   b. Use 8d. finishing nails and set them well.
   c. Assemble the window screens and fit them to the openings before the wire is nailed in place.
   d. Paint all the woodwork before the netting is nailed on. Touch up with paint the nail heads in the moldings after these are nailed in place.

REFERENCES

1. *Free bulletins and circulars.*
Drying Vegetables and Fruits for Home Use. Department Circular No. 3, 1919, United States Department of Agriculture.
Home-Made Apparatus for Drying Fruits and Vegetables. Bray, G. E. Extension Bulletin, No. 13, 1917, Kansas State Agricultural College, Manhattan.
Home-Made Fireless Cookers and their Use. Farmers' Bulletin No. 771, 1918.
Farmhouse, The. Young, Helen Binkerd. Cornell Reading Course, vol. II, No. 39, 1913.
Farm Home Conveniences. Farmers' Bulletin No. 927, 1918.
Fly Traps and their Operation. Farmers' Bulletin No. 734, 1916.
2. *Text or reference books.*
Burton, Myron G. *Shop Projects Based on Community Problems.* Vocational Supply Co., Indianapolis.
Brace, Geo. M., and Mayne, D. D. *Farm Shopwork.* American Book Co.
Blackburn, Samuel A. *Problems in Farm Woodwork.* Manual Arts Press.
Roehl, Louis M. *Agricultural Woodworking.* Bruce Publishing Co.
Roehl, Louis, M. *Farm Woodwork.* Bruce Publishing Co.
Scott, Rhea C. *Home Labor-Saving Devices, and How to Make Them.* J. B. Lippincott Co.

CHAPTER XVI

SELF-MADE EQUIPMENT FOR THE SCHOOL SHOP OR FOR HOME CONSTRUCTION AND REPAIR WORK

THIS chapter is given over to a description of how to make a number of useful objects that fit in with the needs for equipment in school shops in which construction and repair work are taught. Many of them are equally well adapted to the needs on the home farm. Except where otherwise indicated, these objects were built under the direction of the author by students at the Pennsylvania State College.

Base for Oilstone

1. *Purpose.* If oil or carborundum stones are to be carried around, as in a tool box, such stones should be protected by a box. For stones that are kept in a shop, it is sufficient to place them in a base or half-box. This may be permanently fastened on a work bench or table.

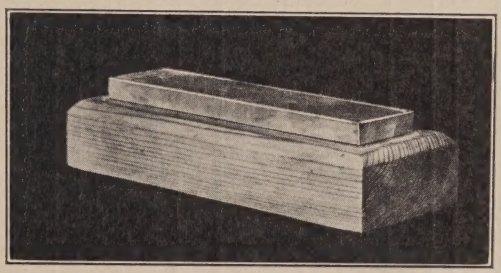


FIG. 207. BASE FOR OILSTONE

2. *Material required.*
   a. *Lumber.* White pine, or other soft, close-grained wood.

NO. OF PIECES	DIMENSIONS	PURPOSE
1	$1\frac{1}{8}'' \times 3\frac{1}{2}'' \times 8\frac{1}{2}''$	Base

   b. *Oil.* A small quantity of boiled linseed oil.
3. *Directions.*
   a. Lay off a rectangle $2'' \times 8''$ at equal distances from the sides of the base block.
   b. With a sharp chisel remove the stock within this rectangle to a uniform depth of $\frac{1}{2}''$.
   c. Plane a chamfer around the upper edge of the base as shown.
   d. Finish with several coats of boiled linseed oil.

File Handles

1. *Purpose.* Instead of a corn cob, or a piece of buggy spoke, or fork handle, it is better to use file handles such as shown in Fig. 209. The various steps in making file handles with and without ferrules is shown.

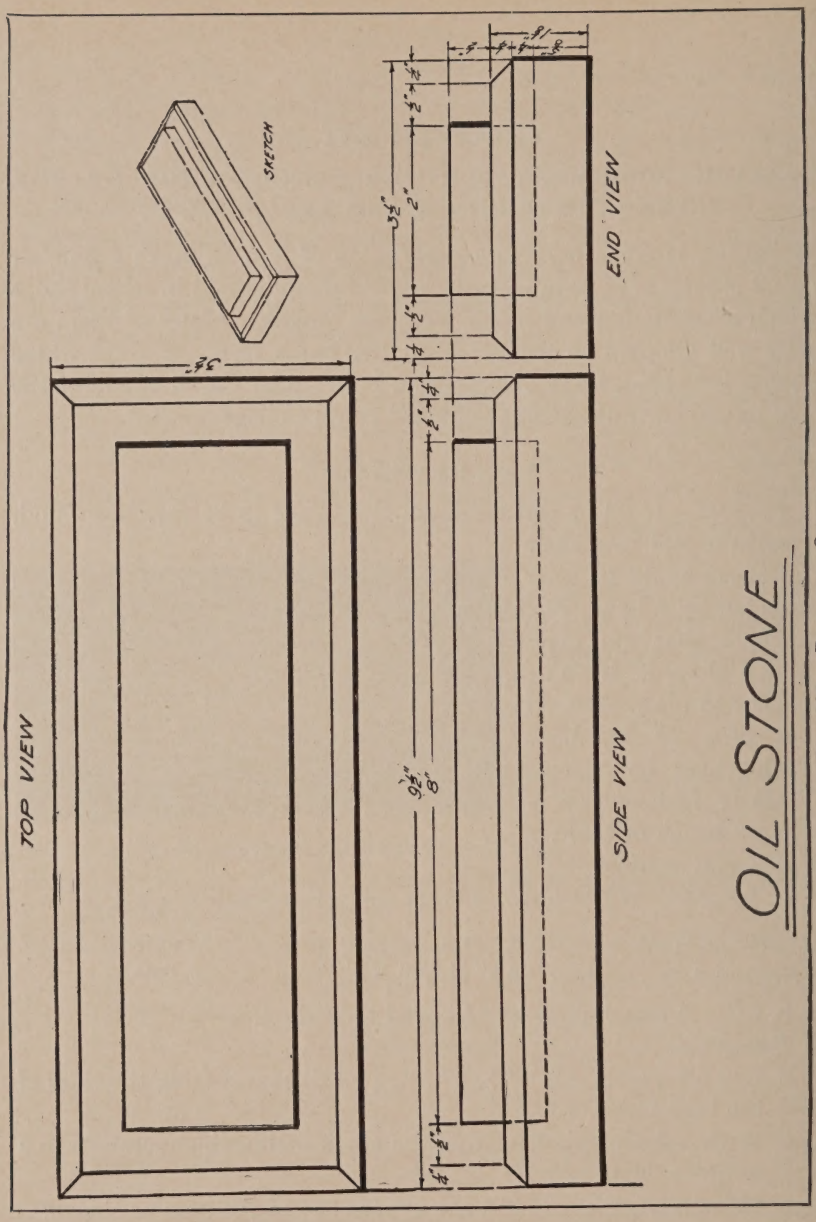


FIG. 208. BASE FOR OILSTONE

2. *Material required for two handles.*

a. *Lumber.* White pine, basswood, yellow poplar, maple, etc.

No. of Pieces	Dimensions	Purpose
1	$\frac{13}{16}'' \times \frac{13}{16}'' \times 11\frac{1}{4}''$	Handles

b. *Hardware.* One or two iron or brass ferrules ½″ diameter, by ⅜″ long.

3. *Directions.*

a. Square up the stock as shown.

b. Lay off an octagon on both ends of the piece.
c. With a plane work the piece to octagon shape.
d. With a spokeshave or a plane taper the ends as shown in the drawing.
e. With saw and chisel separate the two handles.
f. Cut ferrules from brass or wrought-iron tubing with a hack saw, and fit these ferrules as shown.
g. Drill, or burn in with heated end of old file holes to receive tang of file.
h. Round off butt end of file handles.

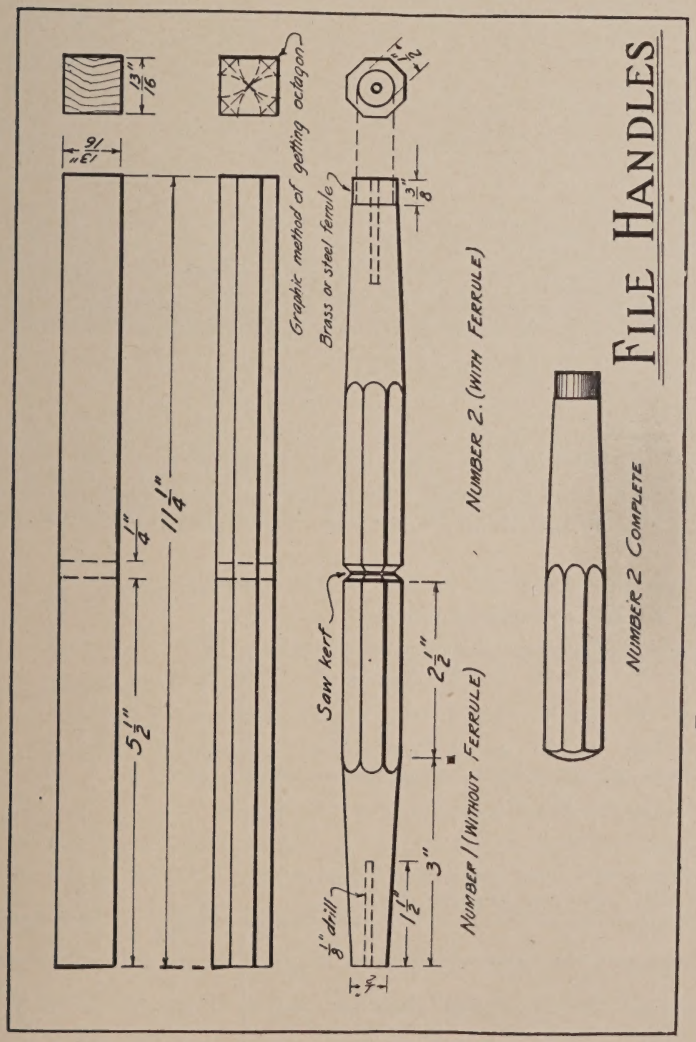


FIG. 209. FILE HANDLE CONSTRUCTION

Rack for Drills, Bits, etc.

1. *Purpose.* A simple rack may be made for drills, bits, countersinks, reamers, and other small parts of that kind by boring holes of proper size into a piece of plank.
2. *Material required.* All that is required is a piece of $1\frac{3}{4}'' \times 5\frac{5}{8}'' \times 20''$ plank, preferably of white pine, fir, cypress, or similar wood, and a little linseed oil.

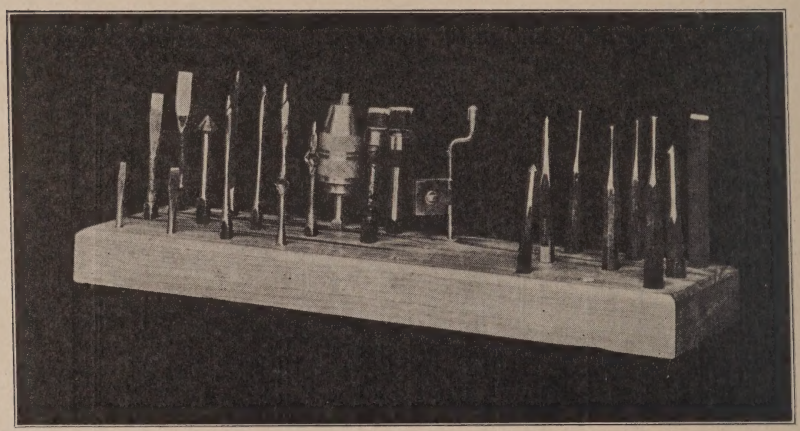


FIG. 210. PORTABLE RACK FOR DRILLS AND BITS

3. *Directions.*
   a. The dimensions given are merely suggestive.
   b. Lay out the holes and bore them.
   c. Plane the plank on all surfaces.

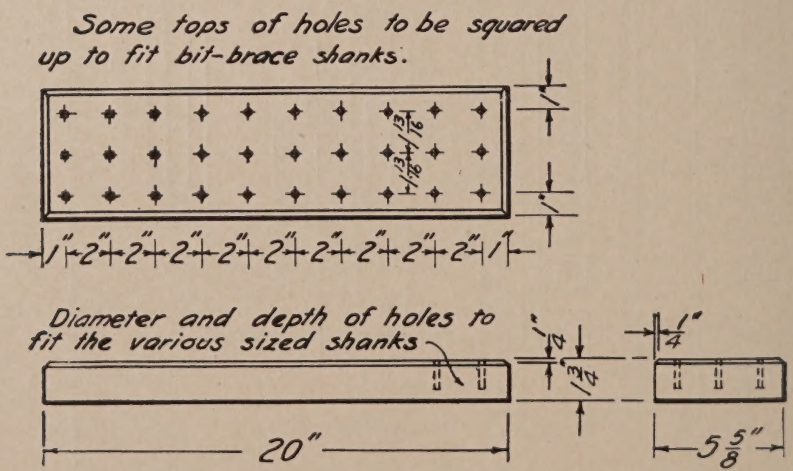


FIG. 211. PORTABLE RACK FOR DRILLS AND BITS

d. Chamfer the corners.
e. Finish with boiled linseed oil.

File Rack

1. *Purpose.* Time and labor is saved by having a definite place for all tools. The rack shown herewith is designed to give various kinds of files proper place.
2. *Material required.*
   a. *Lumber.* White pine or other soft, close-grained lumber.

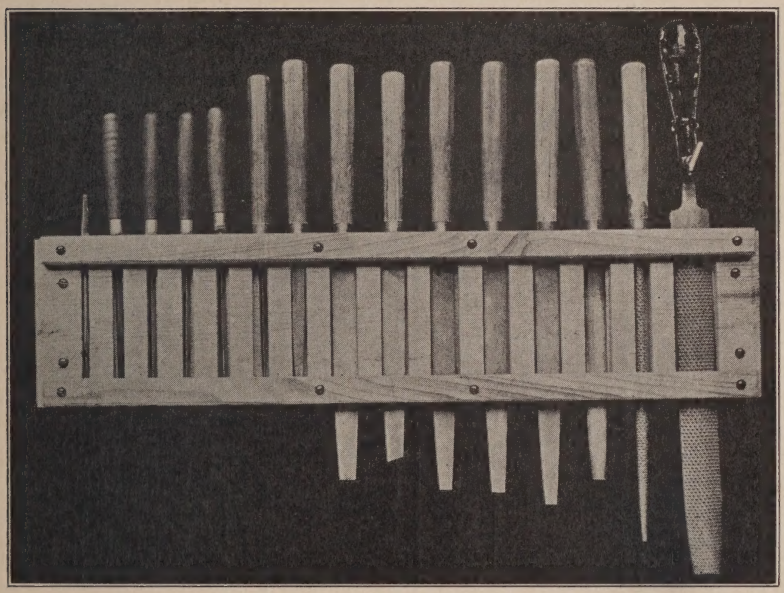


FIG. 212. FILE RACK

No. of Pieces	Dimensions	Purpose
1	$1\frac{3}{4}'' \times 5\frac{1}{2}'' \times 23\frac{3}{8}''$	Base
2	$\frac{1}{2}'' \times \frac{3}{4}'' \times 22\frac{5}{8}''$	Cleats

   b. *Hardware.*
      8 1¼″ No. 8 round-head blued screws.
      4 2¾″ No. 8 round-head blued screws.
   c. *Oil.* Small amount of boiled linseed oil.
3. *Directions.*
   a. Lay off the base with lines spaced as shown in the drawing.
   b. Cut notches to proper depth with a cross-cut saw. Use a small wooden strip as a guide. Tack this along the line to be sawed, with 3d. brads. Place the latter where the holes will not show.
   c. A miter box can also be used to advantage in cutting the notches.
   d. Turn the screws so that the slots will all point in the same direction.
   e. Finish with linseed oil.

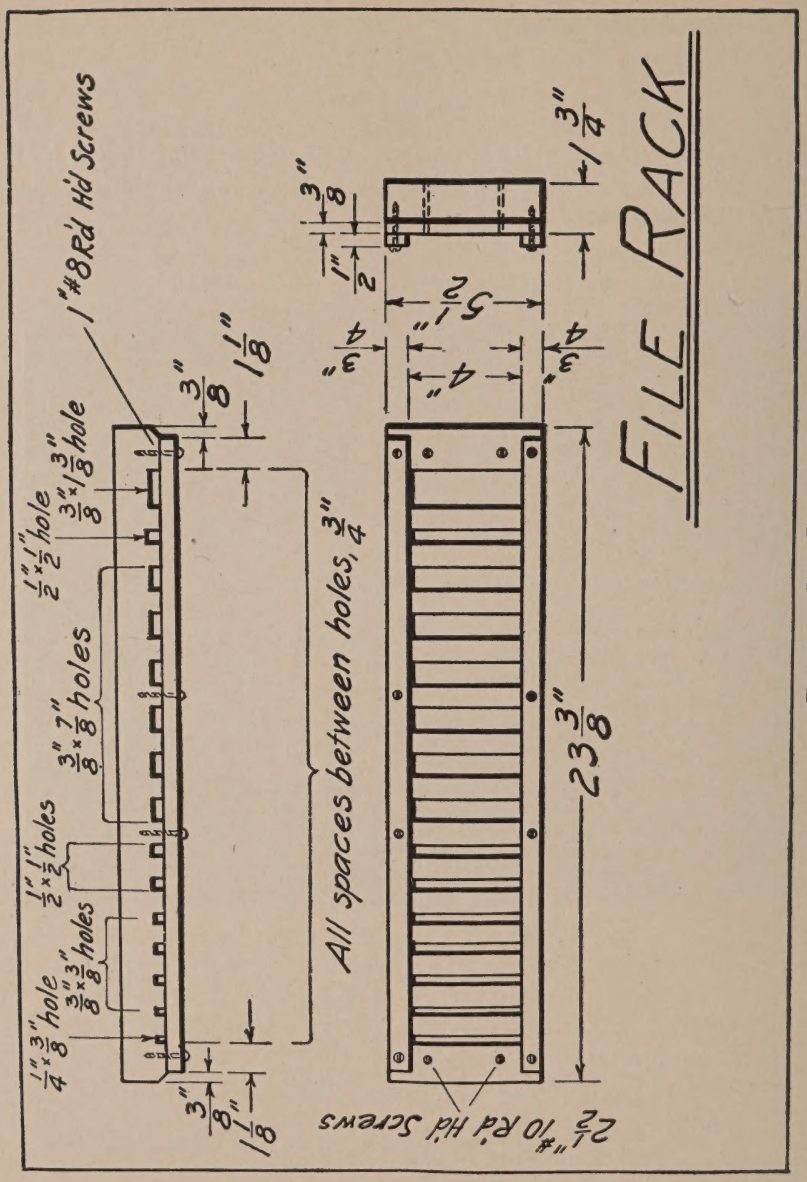


FIG. 213. FILE RACK

Miter Box

1. *Purpose.* A home-made miter box as shown herewith is a labor-saving device that is useful to farmers as well as mechanics. The one shown has its front side projecting lower than the bottom. This helps to keep the box in position when placed on a work bench or on a sawhorse.

2. *Material required.*

a. *Lumber.* Straight, well-seasoned lumber. Either soft or hard wood.

No. of Pieces	Dimensions	Purpose
1	$1\frac{1}{8}'' \times 5\frac{1}{2}'' \times 2'$	Bottom
1	$\frac{13}{16}'' \times 4\frac{1}{8}'' \times 2'$	Front
1	$\frac{13}{16}'' \times 3\frac{1}{2}'' \times 2'$	Back

b. *Hardware.* 1 doz. 8d. finishing nails.

3. *Directions.*

a. Plane all sides of stock smooth and true.

b. Nail front and back to bottom, making sure that they make a right angle with it. Also place nails so that they will not come

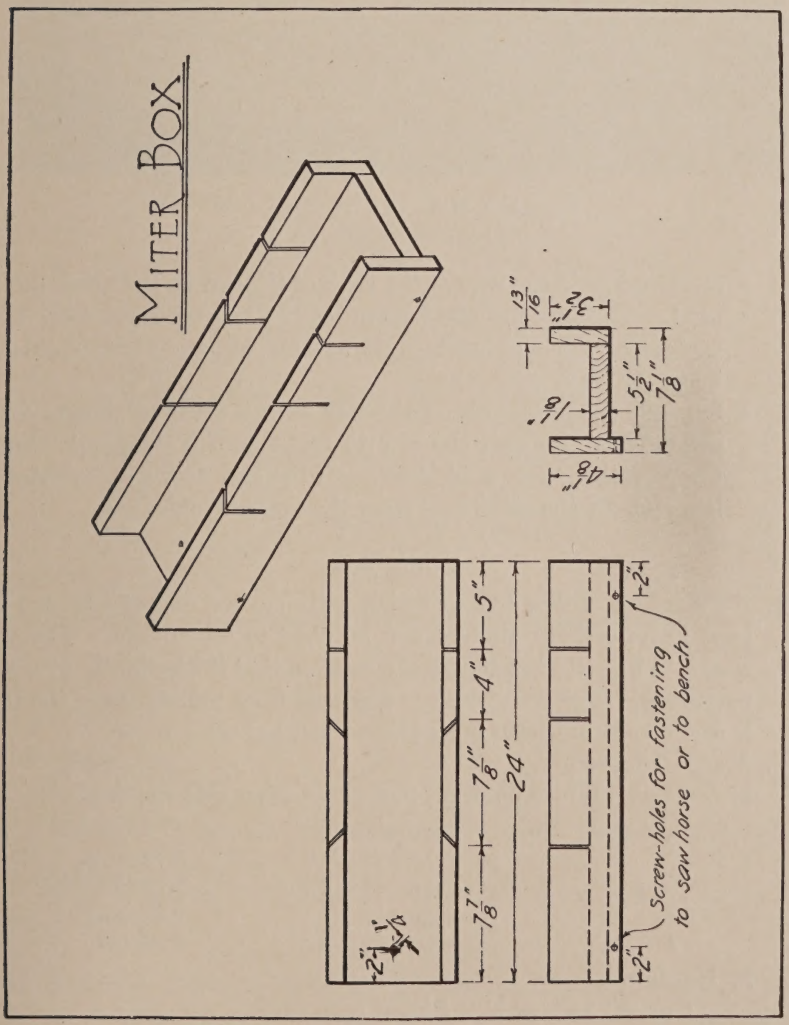


Fig. 214. Miter Box

FIG. 215. UTILITY BOX

Nails, screws, staples, etc.

crosswise or in the way of the path of the saw as the miter box is used. Through use the bottom of the box may get deep saw-kerfs along the lines in which the saw travels, and nails should not be in the way.

c. Lay out the saw-kerfs on the box with a framing square, very carefully, and watch the saw to make sure it does not "run" when cutting these guide-kerfs. If the saw does run reverse the box and cut the same kerf from the opposite side.

Utility Box

1. *Purpose.* A utility box in which nails, screws, and staples can be kept in an orderly manner can be used to advantage. The one shown in Fig. 216 has the lid arranged so that it fits tightly over the partitions. This prevents the contents from mixing when the box is carried around from one place to another.
2. *Material required.*

a. *Lumber.* White pine, fir, poplar, or other soft wood.

No. of Pieces	Dimensions	Purpose
1	½″ × 7½″ × 20½″	Bottom
2	½″ × 2½″ × 20½″	Front and back
2	½″ × 3″ × 8½″	Ends
5	½″ × 2″ × 7½″	Partitions
1	½″ × 2″ × 20½″	Partition

b. *Hardware.*

1 pr. 3″ narrow butt hinges with screws.

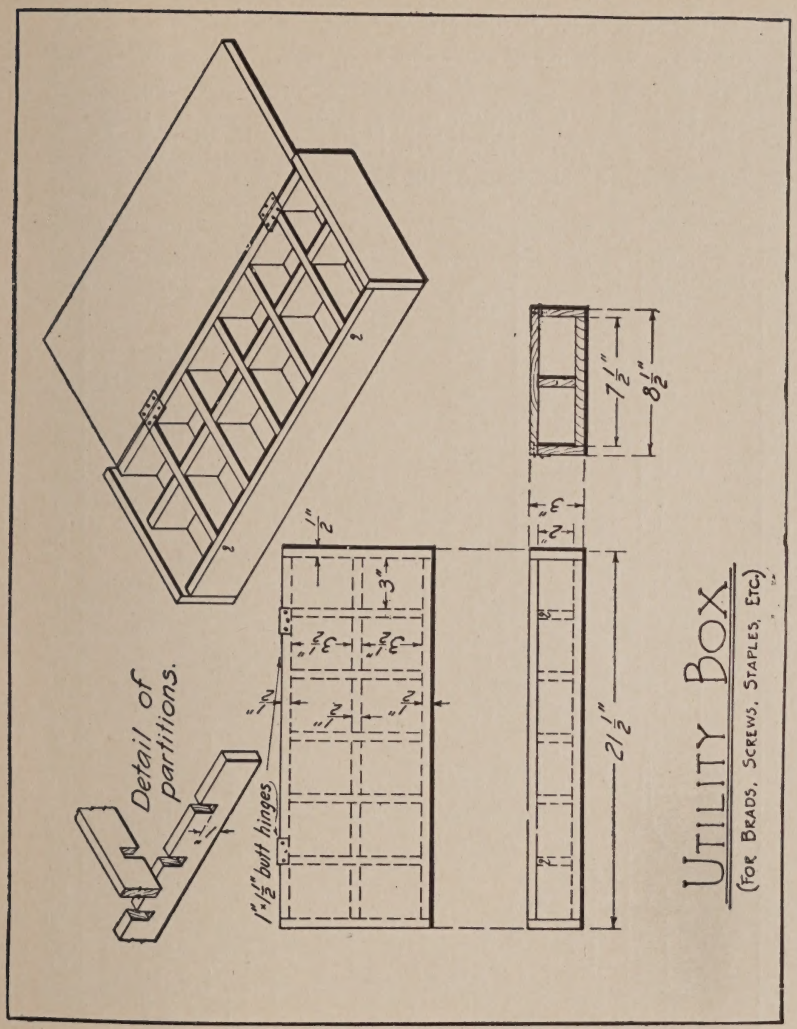


FIG. 216. UTILITY BOX
Nails, screws, staples, etc.

1 doz. 1¼" flat-head bright screws.
3 doz. 6d. finishing nails.
2 hooks with escutcheon pins

3. *Directions.*
   a. Assemble the box before placing partitions.
   b. Halve partitions together as shown; nail them through bottom and sides.
   c. Gain hinges into top and back so that cover will fit tightly.

Saw Jointers

1. *Purpose.* Two types of saw jointers are shown. They are made so that the file that is placed in them will be at right angles to the blade of the saws to be jointed.

2. *Material required for jointer No. 1.*

a. *Lumber.* Hard wood such as ash or oak.

No. of Pieces	Dimensions	Purpose
1	$^{13}/_{16}'' \times {}^{13}/_{16}'' \times 3\frac{1}{2}''$	Body
1	$^{9}/_{16}'' \times {}^{13}/_{16}'' \times 4''$	Key

b. *Hardware.* 5″ single-cut mill file.

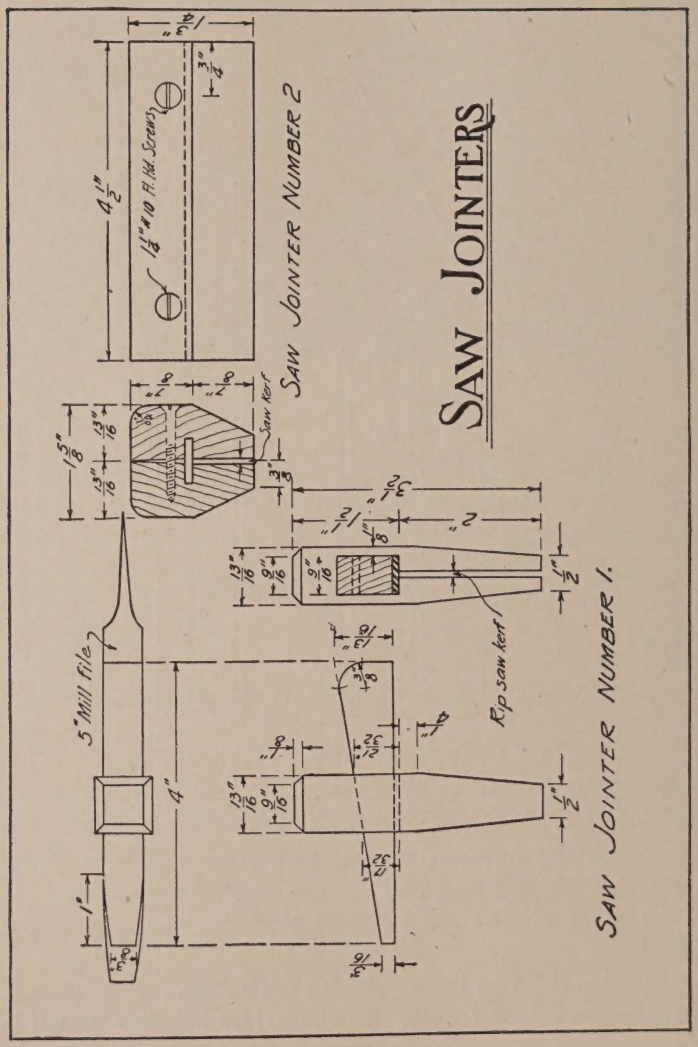


Fig. 217. Two "Home-Made" Saw Jointers

3. *Directions.*

a. Lay off and mortise hole for key.

b. Trim up jointer to desired shape.

c. Cut lower part into two equal parts with rip-saw.

d. Make key to hold file in position.

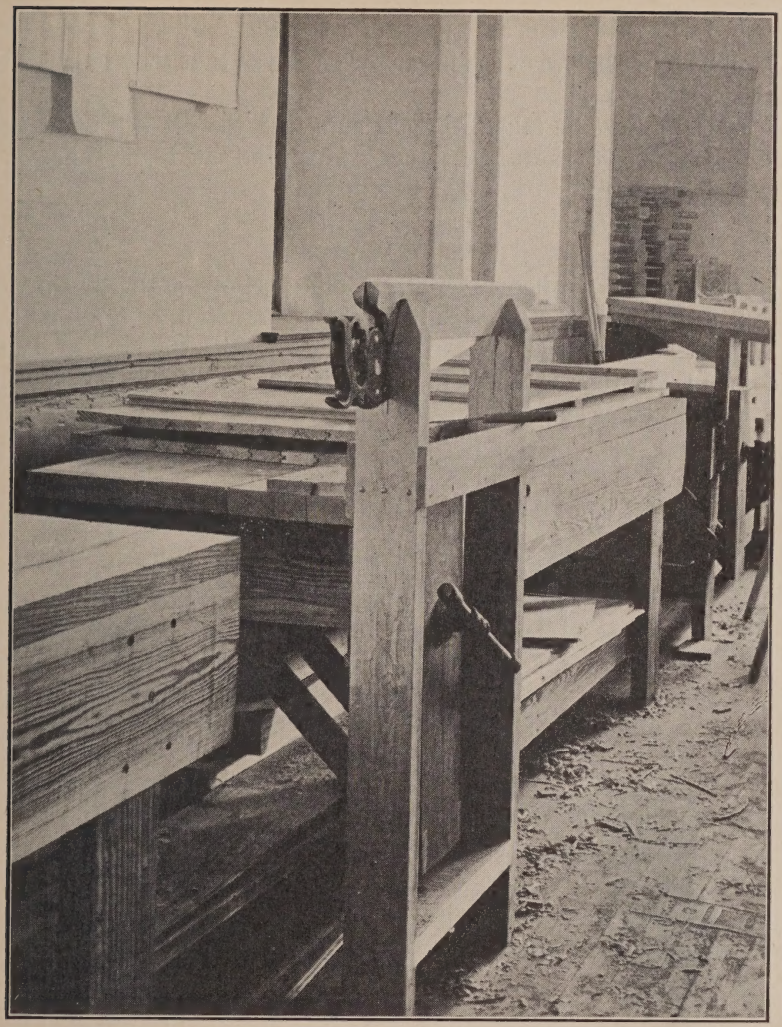


FIG. 218. SAW FILING CLAMP

4. *Material required for jointer No. 2.*
   a. *Lumber.* Hard wood or close-grained soft wood.

No. of Pieces	Dimensions	Purpose
2	$13/16'' \times 1\frac{3}{4}'' \times 4\frac{1}{2}''$	Body

   b. *Hardware.*
      2 1¼″ No. 10 flat-head bright screws.
      5″ single-cut mill file.
5. *Directions.*
   a. The file in this jointer is held in place by the compression exerted by the two screws.

b. Use a saw to cut the grooves for the file.

c. The two halves of the jointer are made so that they touch at the top only.

d. Care must be taken to make sure that the file will lie at right angles to the saw-kerf through which the saw blade is passed in jointing.

Saw Filing Clamp

1. *Purpose.* Two home-made saw filing clamps are shown in Fig. 219. They differ principally in the construction of the jaws that hold the saw blade. Clamp No. 1 is made with the back of the file box lower than the bottom, so that it can be slipped into a work-bench vise as shown in Fig. 218.

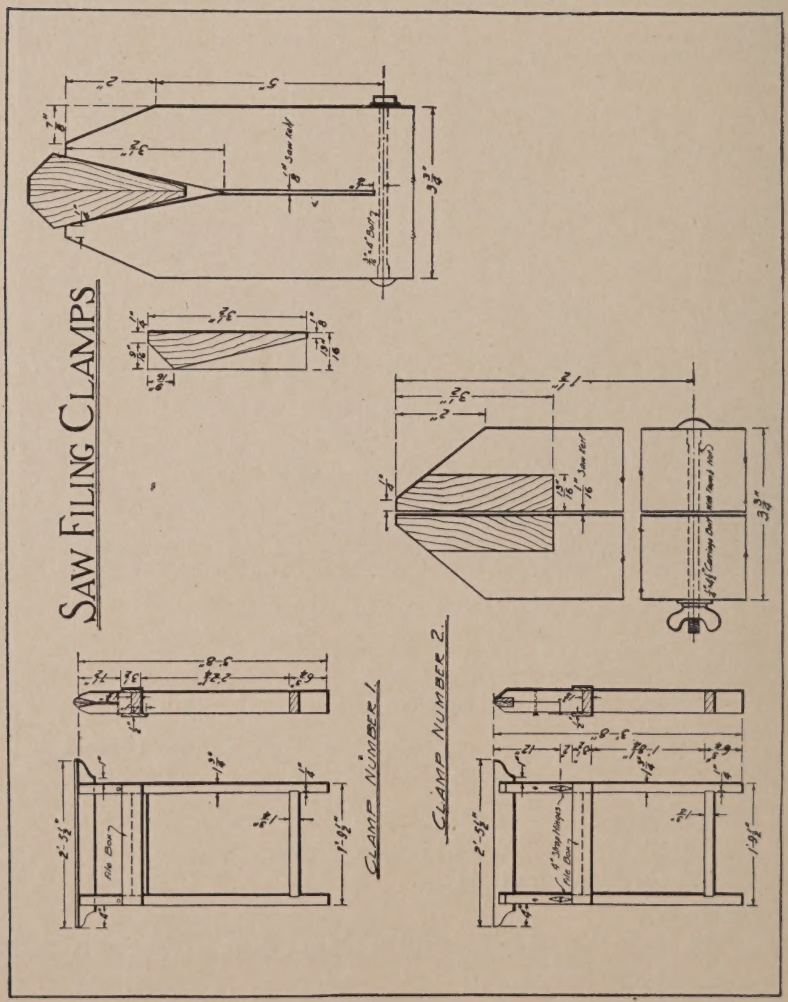


FIG. 219. TWO SAW FILING CLAMPS

2. *Material required for clamp No. 1.*

a. *Lumber.* White pine, cypress, fir, yellow pine, etc.

No. of Pieces	Dimensions	Purpose
2	1¾″ × 3¾″ × 3′ 8″	Uprights
2	1¾″ × 3¾″ × 1′ 6½″	Cross-ties
1	½″ × 4½″ × 1′ 9½″	Back of file box
1	½″ × 3½″ × 1′ 9½″	Front of file box
2	13/16″ × 3½″ × 2′ 5½″	Jaws

b. *Hardware.*

2 3/16″ × 4″ carriage bolts with washers.

1 doz. 16d. common wire nails.

2 doz. 6d. finishing nails.

3. *Directions.*

a. Gain the cross-ties into the uprights ¼″.

b. The jaws are made from two pieces of 13/16″ × 3½″ material. Rough them into shape with a drawing knife or a hatchet, and smooth up with a plane.

c. Draw bolts are placed 7″ from the top ends of the uprights to prevent the pieces from splitting in case the wedges are driven too tightly.

4. *Clamp No. 2.*

a. *Material required.* The material required for this clamp is the same as for clamp No. 1, except that the bolts are ½″ longer, and have wing nuts, and a pair of 4″ strap hinges are also required.

Clamp No. 2 is a little harder to make, but is also somewhat more satisfactory because the saws are more easily adjusted than in clamp No. 1.

b. *Directions.* The method of construction is essentially the same as for clamp No. 1. The difference in the construction is shown in the detail drawing.

Tool and Nail Box

1. *Purpose.* This tool and nail box is planned for a few tools such as a hammer, screwdriver, push drill, block plane, rule, and monkey wrench, and for a few brads, nails, and screws such as are frequently used in little repair jobs about the home or on the farmstead.

2. *Material required.*

a. *Lumber.* White pine, basswood, yellow poplar.

No. of Pieces	Dimensions	Purpose
1	½″ × 7″ × 1′ 6½″	Bottom
2	¼″ × 2½″ × 1′ 7″	Sides
4	¼″ × 2″ × 3¼″	Partitions
2	¼″ × 2″ × 2¼″	Partitions
1	½″ × 4⅜″ × 1′ 6½″	Partition
2	¼″ × 2½″ × 7″	Ends

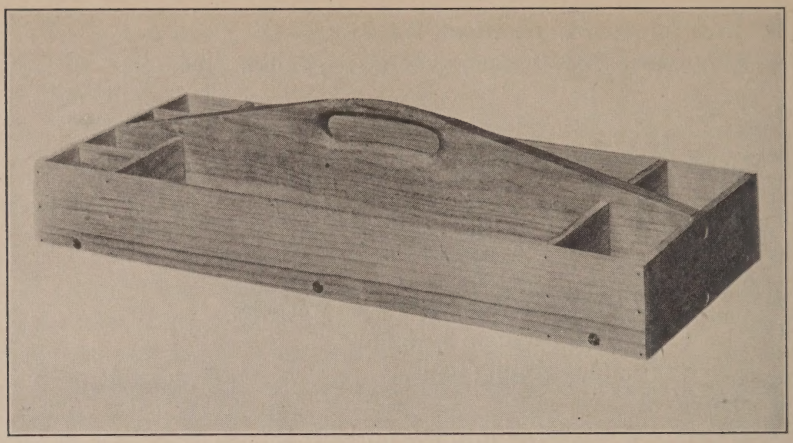


FIG. 220. TOOL AND NAIL BOX

b. *Hardware.*

14 ¾″ flat-head bright screws.
3 1¼″ flat-head bright screws.
⅒ lb. 3d. wire brads.
⅒ lb. 4d. wire brads.

3. *Directions.*

a. Select good sound lumber especially for the board into which the handle is cut.

b. The longitudinal partition is fastened by screwing through the ends and through the bottom of the box.

c. The small partitions are nailed in place.

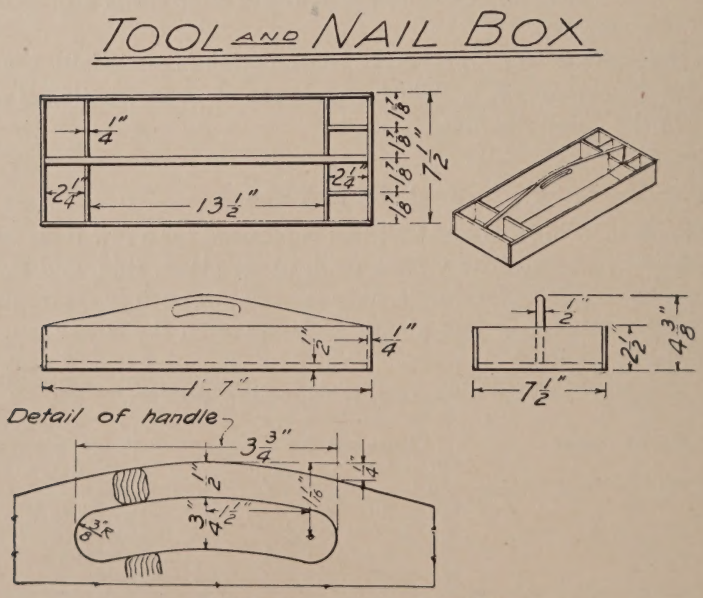


FIG. 221. TOOL AND NAIL BOX

Mallet

1. *Purpose.* If much chiseling is to be done, a mallet is desirable. It is not as hard on chisel handles as a hammer is. If a hammer is used, it should be used flat-wise.

   The mallet shown herewith is made without the use of machinery of any kind. It is of nice weight and makes a satisfactory tool.

2. *Material required.*

   a. *Lumber.* Hickory.

No. of Pieces	Dimensions	Purpose
1	$2\frac{1}{2}'' \times 3'' \times 5\frac{1}{2}''$	Head
1	$1\frac{1}{8}'' \times 1\frac{1}{8}'' \times 13''$	Handle
1	$\frac{1}{8}'' \times \frac{7}{8}'' \times 1\frac{1}{2}''$	Wedge

   b. *Oil.* A small quantity of boiled linseed oil.

3. *Directions.*

   a. Lay off center lines on the piece from which the handle is to be made. Measure out from these lines at certain points shown in the drawing. Cut in the required depth with a saw and use a chisel, shaping the handle to proper dimensions but rectangular in outline.

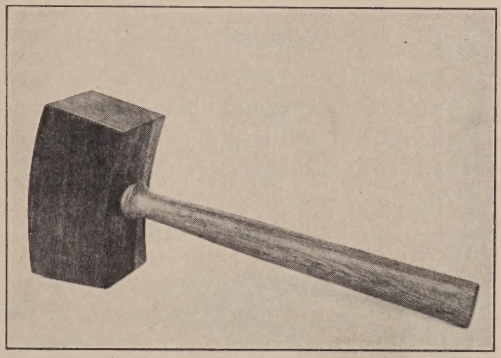


Fig. 222. Mallet

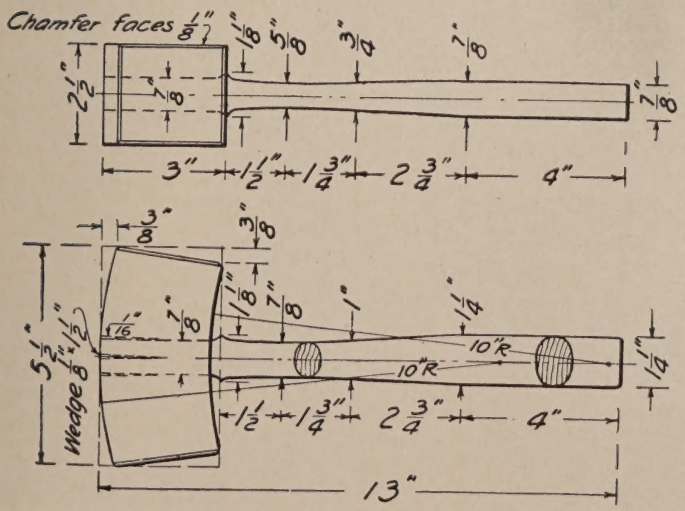


Fig. 223. Mallet

b. With a spoke shave or cabinet rasp next bring the handle to the required oval outline.
c. In boring the hole through the head, bore from both ends.
d. With a half-round file widen the hole at the outer end of the head into oval shape, so that the handle cannot pull out if wedged tightly.
e. The outline for the head may be marked from a cardboard template. The outer curve is planed to shape with a smooth plane.
f. The inner curve is made by cutting saw-kerfs of proper depth, and by chiseling out the material to the depth of the saw-kerfs. Finish, with sandpaper placed on a curved block.
g. Give the mallet several coats of boiled linseed oil.

Sawhorse

1. *Purpose.* Sawhorses are widely used in connection with repair and construction work involving lumber. Their proportions are fairly well standardized. The drawing shows how to get the proper lengths of the legs and the bevels by means of a framing square. In the average school shop the pupils do too much sawing on bench tops and not enough on sawhorses. Every school shop ought to be equipped with two or three pairs of horses.

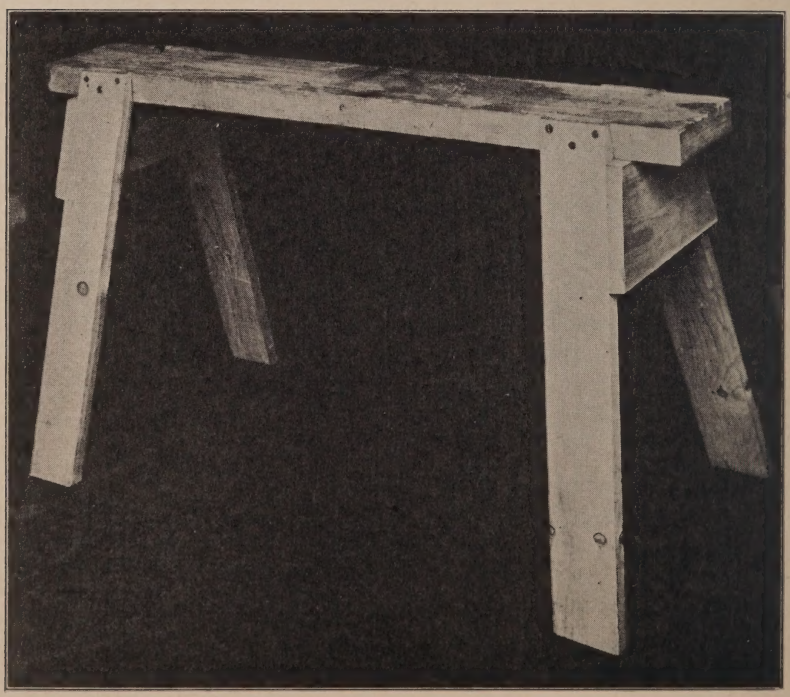


FIG. 224. SAWHORSE

2. *Material required.*

a. *Lumber.* Soft wood is usually used, such as pine, fir, and cypress.

No. of Pieces	Dimensions	Purpose
4	$1\frac{3}{16}'' \times 3\frac{1}{2}'' \times 25''$	Legs
1	$1\frac{3}{4}'' \times 5\frac{3}{4}'' \times 3'\ 4''$	Top
2	$1\frac{3}{16}'' \times 5\frac{1}{2}'' \times 10''$	End spreads.

b. *Hardware.*

1 doz. 1¾ No. 10 flat-head bright screws.

1 doz. 8d. finishing nails.

3. *Directions.*

a. The drawing shows how to obtain the length of the legs and the bevels.

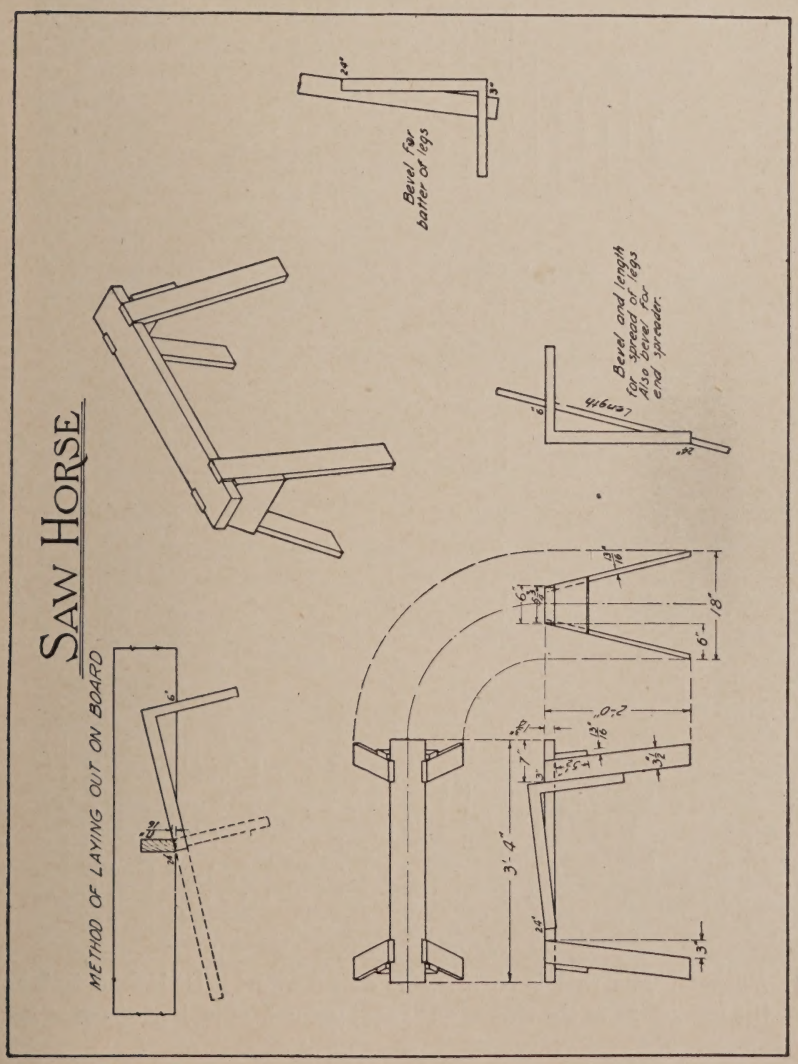


FIG. 225. SAWHORSE SHOWING LAYOUT WITH FRAMING SQUARE

b. On any convenient board lay out a full-size section of the top piece as shown in the drawing. Apply the square to this, using the same numbers as in getting the length of the legs (6 and 24 — 6 representing the spread, and 24 the perpendicular height).

The square then represents in direction the leg of the horse, and the distance to be notched out in order to give the leg a uniform bearing can be measured.

c. Screw the legs to the top, and nail or screw the end spreads to the legs.

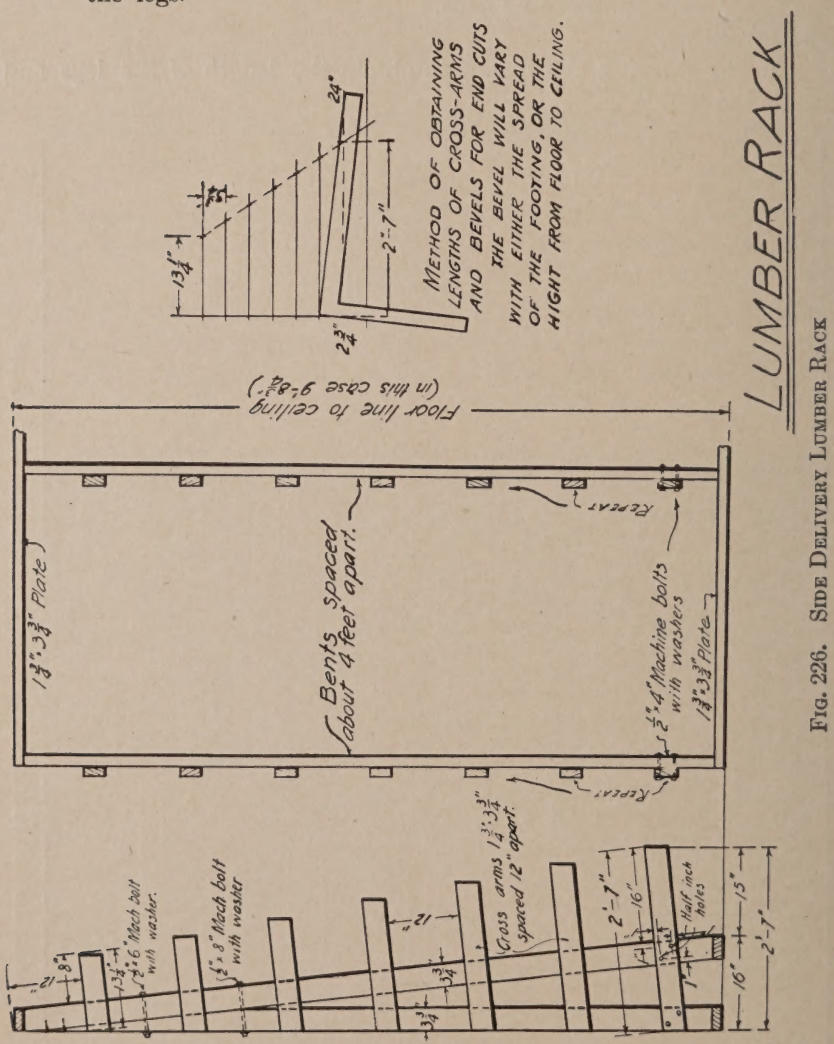


Fig. 226. Side Delivery Lumber Rack

Lumber Rack

1. *Purpose.* This rack is particularly useful where it is desired to take the lumber from the side of the rack, because of lack of space at the

ends. It offers a large storage capacity for the amount of floor space occupied. The rack is so designed that it will stand without being fastened to wall or ceiling, but it is safer to fasten it, as boys are likely to climb on it and tip it over. A good way to fasten it without bolts or straps is to make it ceiling height and then wedge it between floor and ceiling.

2. *Material required for three bents.*

a. *Lumber.* Yellow pine, or any kind of soft or hard wood.

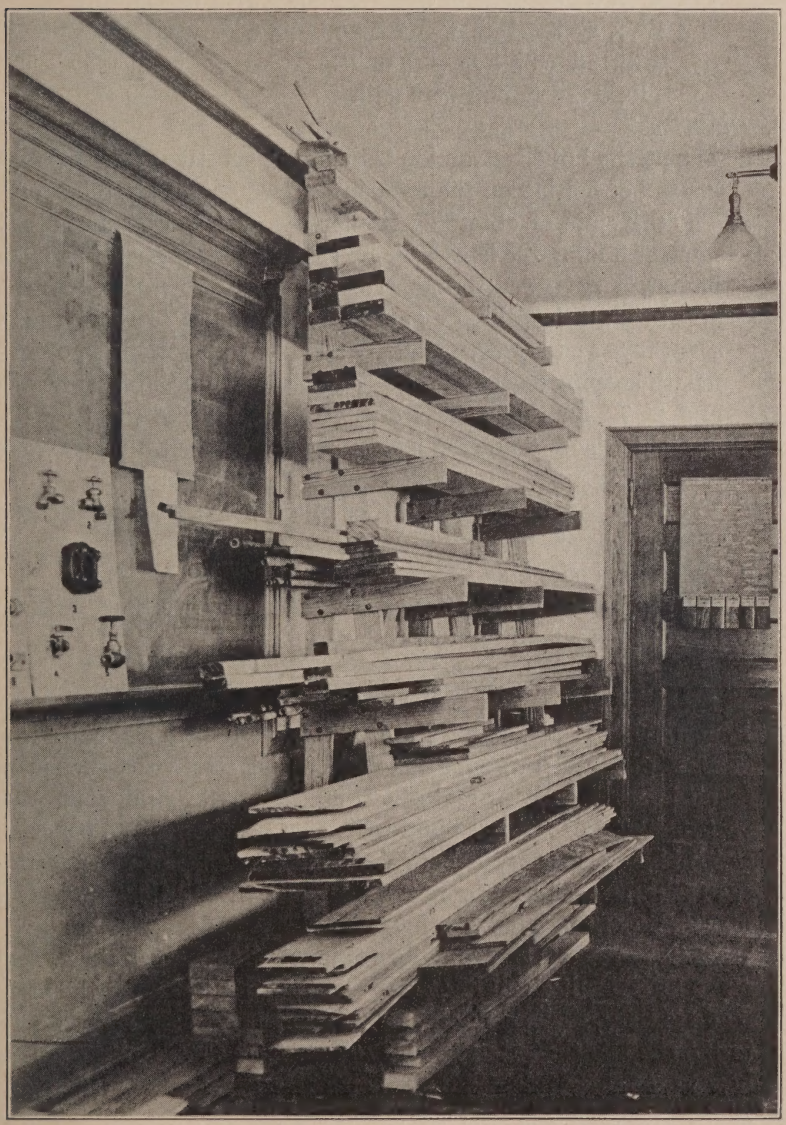


FIG. 227. SIDE DELIVERY LUMBER RACK

No. of Pieces	Dimensions	Purpose
2	1¾″ × 3¾″ × 12′	Lower plates
1	1¾″ × 3¾″ × 12′	Upper plate
6	1¾″ × 3¾″ × 10′ (approx.)	Uprights
3	1¾″ × 3¾″ × 14′	Cross-arms
2	13/16″ × 3¾″ × 10′	Braces

b. *Hardware.*

71 ½″ × 4″ carriage or machine bolts with washers.
3 ½″ × 6″ carriage or machine bolts with washers.
3 ½″ × 8″ carriage or machine bolts with washers.
¼ lb.16d. common wire nails.
¼ lb. 8d. common wire nails.

3. *Directions.*

a. The method of construction is merely suggestive. For example, instead of bolting on the cross-arms, they might be spiked on.

b. The principle of obtaining the lengths of the cross-arms is the same as finding the lengths of a series of rungs or steps in a ladder having a narrower top than bottom. Cut the cross-arms to approximate lengths, or gather up a number of short ends of scantlings and lay them side by side. Arrange them in order of length keeping one end flush. Lay off 13¼″ on the shortest piece and 2′ 7″ on the longest one. Connect these points with a straight edge. The true length of each cross-arm is thus given graphically.

c. The bevel for the end cuts can be found with a framing square or with a T bevel.

d. Space the bents about four feet apart.

e. Spike plates to bents before raising the framework, or spike top plate to bents and toe-nail to lower plates.

Work Bench

1. *Purpose.* Farmers do not find it profitable to own elaborate work benches with glued-up tops and rapid acting steel vises, such as are found in cabinet shops and other industrial establishments. The vast majority of farmers build their own benches. The bench described herewith is typical of good home-made bench construction, such as can be built by farmers and others without the use of power machinery of any kind.

While the school shop may be equipped with some of the factory-made benches, it should not be overlooked that some of the home-made variety, such as described herewith, ought also to find a place in the shop so that the boys may know from first-hand experience how to build work benches on their home farms.

2. *Material required.*

a. *Lumber.* The top and the lumber used in the vises should

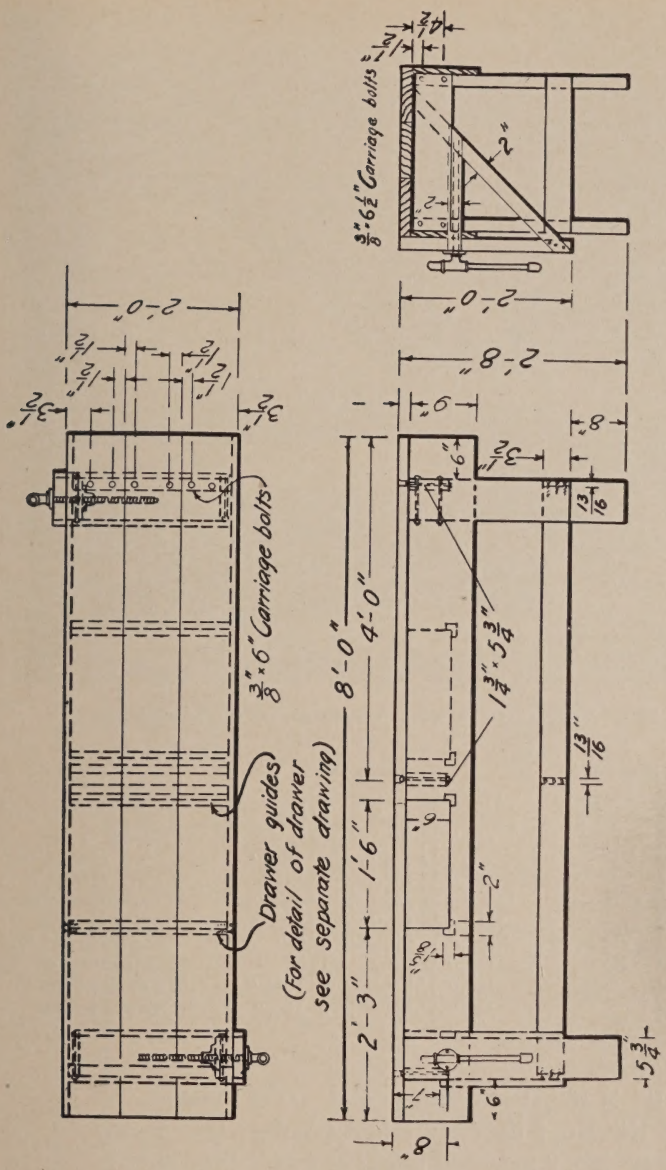


FIG. 228. WORK BENCH

preferably be of hard wood. The body can be made of yellow pine, or similar lumber. The bench ought to be from 6′ to 8′ long, and about two feet wide, with two vises. For the home farm one may well be for wood, and the other a blacksmith's or a machinist's vise.

For a work bench as shown in Fig. 228, exclusive of bench stop and of drawers, the following material is required:

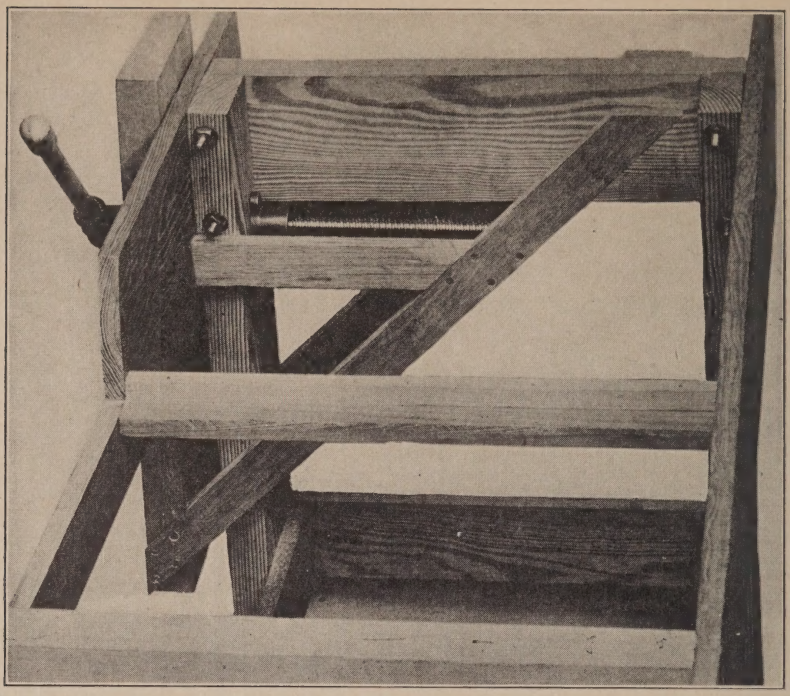


FIG. 229. VISE AND DRAWER CONSTRUCTION ON WORK BENCH

NO. OF PIECES	DIMENSIONS	PURPOSE
3	1¾″ × 12″ × 8′	Top
4	1¾″ × 5¾″ × 2′ 6¼″	Legs
2	13/16″ × 9″ × 8′	Aprons
2	13/16″ × 3½″ × 1′ 10⅜″	Lower cross-ties
1	13/16″ × 3½″ × 1′ 5¼″	Lower cross-tie
3	1¾″ × 5¾″ × 1′ 10⅜″	Upper cross-ties
2	1¾″ × 7¾″ × 24″	Fronts of vises
4	13/16″ × 2″ × 31½″	Diagonals of vises
4	13/16″ × 2″ × 17″	Horizontals of vises
4	13/16″ × 2″ × 1′ 10⅜″	Drawer guides
4	13/16″ × 13/16″ × 1′ 10⅜″	Drawer guides

b. *Hardware.*

2 ⅞″ × 16″ steel bench screws. (For vises.)

28 1½″ No. 8 flat-head bright screws. (For vises.)

20 ¾″ No. 9 flat-head bright screws. (For vises.)

18 ⅜″ × 7″ carriage bolts with washers to bolt top to upper cross-ties.

16 ⅜″ × 6½″ carriage bolts with washers to bolt upper cross-ties to legs.

5 doz. 1½″ No. 8 flat-head bright screws for fastening aprons, braces, lower cross-ties and drawer guides.

16 6d. common wire nails for fastening braces to legs.

c. *Oil.* 1 pint boiled linseed oil.

3. *Directions.*
   a. Cut all material for a certain kind such as legs, cross-ties, top planks, etc., from one pattern so that the respective parts will match up.
   b. A twist drill may prove more satisfactory than an auger bit for boring holes through the top cross-ties, and through the legs. The holes can be bored from opposite sides of the pieces if it is found that the grain of the wood deflects the auger bit.
   c. Place the bolts in the legs so that they will not interfere with the vise. (See Fig. 229.)

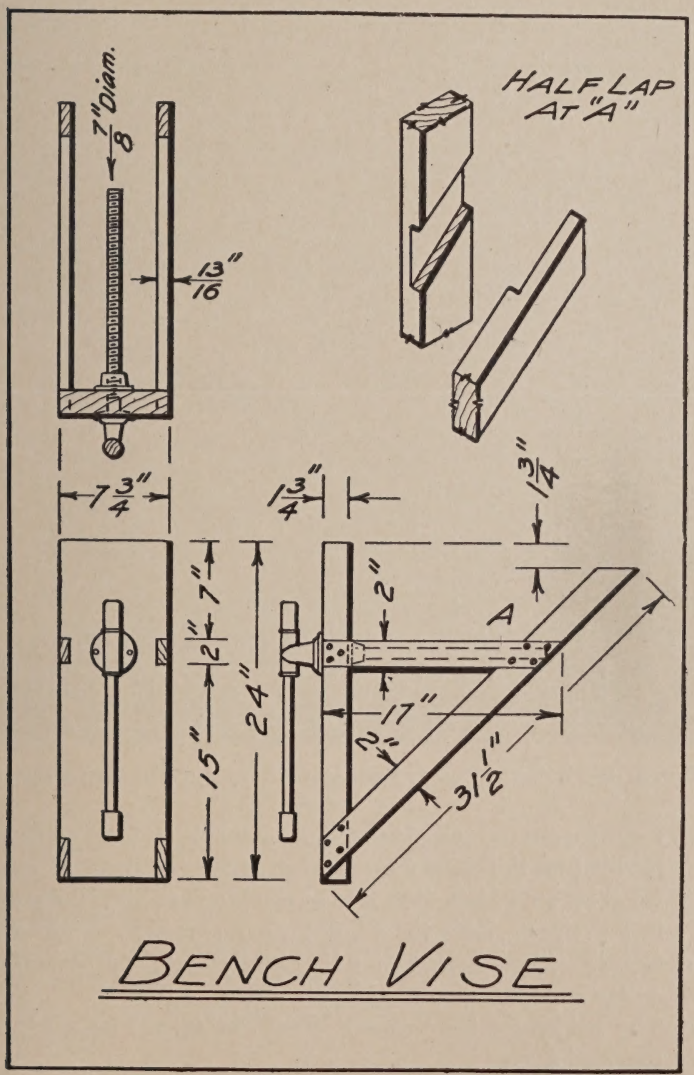


FIG. 230. BENCH VISE

FIG. 231. PLUGGING TOP OF BENCH AFTER BOLTS HAVE BEEN INSERTED

d. In fastening the top planks, first bore holes ¾″ deep with a ¾″ or ⅞″ bit (use the same diameter bit as the diameter of some hard wood broom handle that is to be used to plug these holes as shown in Fig. 231). Bore these holes where shown in the drawing.
e. Continue these holes with a ⅜″ bit all the way through the upper cross-ties. Remove the top planks to do this.
f. The guides for the drawers should be placed before the top is fastened down.
g. To assemble the vise, first bore a hole with an expansive bit so

that the front washer will fit snugly up against the vise. Then continue this hole, which is 8″ from the top of the vise, and equidistant from the sides, with an auger bit 1/16″ or 1/8″ larger than the diameter of the screw to be used. (In this case 7/8″.)

h. Fit all the joints but assemble only at the half-lap joint "A." (Fig. 230.) Insert the parts through the holes in the aprons of the bench and fasten the remaining joints of the vise.

i. The holes in the aprons through which the vise works should be 1/16″ larger all around than the 13/16″ × 2″ pieces in order to work freely. They should be bored and mortised out before they are screwed to the sides of the bench.

j. Be sure not to place a flat-head screw in the apron where the hole for the vise screw is to be bored.

k. The method of plugging the bolt holes in the bench top is shown in Fig. 231. Apply a little liquid glue and drive in the hard wood broom handle snug up against the bolt heads. Next saw off the handle by passing a saw over the bench top without scratching the latter. Smooth up the places with a plane.

l. Dry out the top planks thoroughly before bolting them down.

m. Apply several coats of boiled linseed oil to the whole bench.

n. The drawer construction, and the bench stop are shown separately.

Bench Drawer

1. *Purpose.* This bench drawer (Fig. 232) is made to fit into the work bench just described. Trays may be fitted into the drawer. These may hold screws, brads, and small tools. Notice the simple handle — simply a hole made so that the hand can be inserted to pull the drawer. An ordinary drawer pull would be in the way as one works alongside of the bench.

2. *Material required (for 1 drawer).*

a. *Lumber.* Front to match aprons of bench. Cypress can be used to match yellow pine. Sides, back, and bottom of the drawer should be of white pine or similar wood.

No. of Pieces	Dimensions	Purpose
2	13/16″ × 6″ × 22″	Sides
1	1/2″ × 5 1/8″ × 16 7/8″	Back
1	13/16″ × 6″ × 18″	Front
4	1/2″ × 5 3/4″ × 16 7/8″	Bottom

b. *Hardware.*

2 doz. 6d. finishing nails.

1 doz. 3d. finishing nails.

c. *Oil.* A small amount of linseed oil.

3. *Directions.*

a. The details of construction, such as the method of making the

joints should be varied to suit the tools at one's disposal. A rabbet plane needs to be used for the construction as shown.

b. Glue up the bottom boards in the rough, then smooth them down to suit, and saw to dimensions.

c. Do not nail the bottom boards fast to the sides if the construction as shown in the drawing is used, but simply tack it in place with a single brad driven into the back end piece of the drawer.

d. Nail the joints with 6d. or 8d. finishing nails, placing the nails so that they will not show when the drawer is closed.

e. Finish with linseed oil.

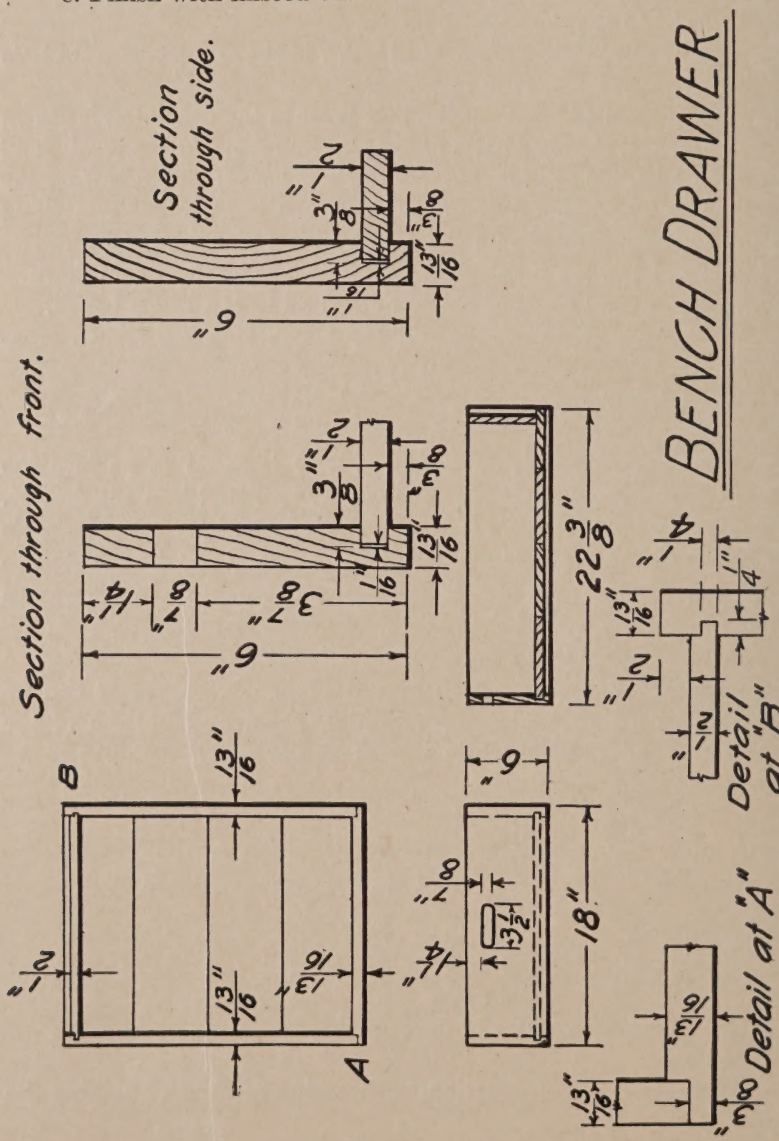


FIG. 232. WORK-BENCH DRAWER
(See Fig. 228.)

Bench Stop

1. *Purpose.* Most persons familiar with work-bench construction have seen the old-fashioned bench stop, made by cutting a V notch into a 6″ × 8″ board, used widely to-day. The stop shown is an improvement that holds stock edgewise much better than the old V block.

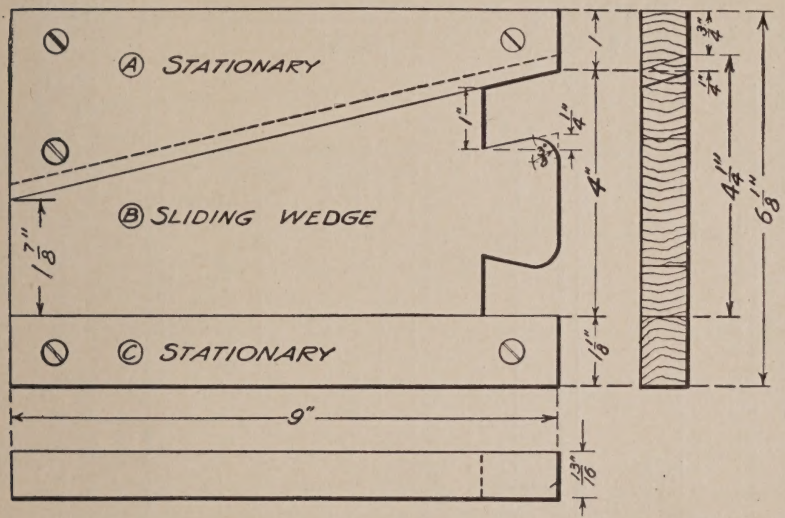


FIG. 233. BENCH STOP FOR BENCH SHOWN IN FIG. 228

2. *Material required.*
   a. *Lumber.* Either hard wood or soft wood is satisfactory.

NO. OF PIECES	DIMENSIONS	PURPOSE
1	13/16″ × 3⅛″ × 9″	Part "A"
1	13/16″ × 4″ × 9″	Part "B"
1	13/16″ × 1⅛″ × 9″	Part "C"

   b. *Hardware.* 5 1½″ No. 10 flat-head bright screws.
3. *Directions.*
   a. Parts "A" and "C" are screwed fast to the bench.
   b. Part "B" is a sliding wedge which is drawn out when a board is placed in the stop and is then pushed back so as to hold the board from slipping while it is being planed.
   c. Note that the sliding wedge "B" has one side beveled. This keeps it from bulging out of place.
   d. Countersink the screws so that they will be ⅛″ or more below the surface. This keeps planes and other cutting tools from being dulled on them.
   e. Finish with boiled linseed oil.

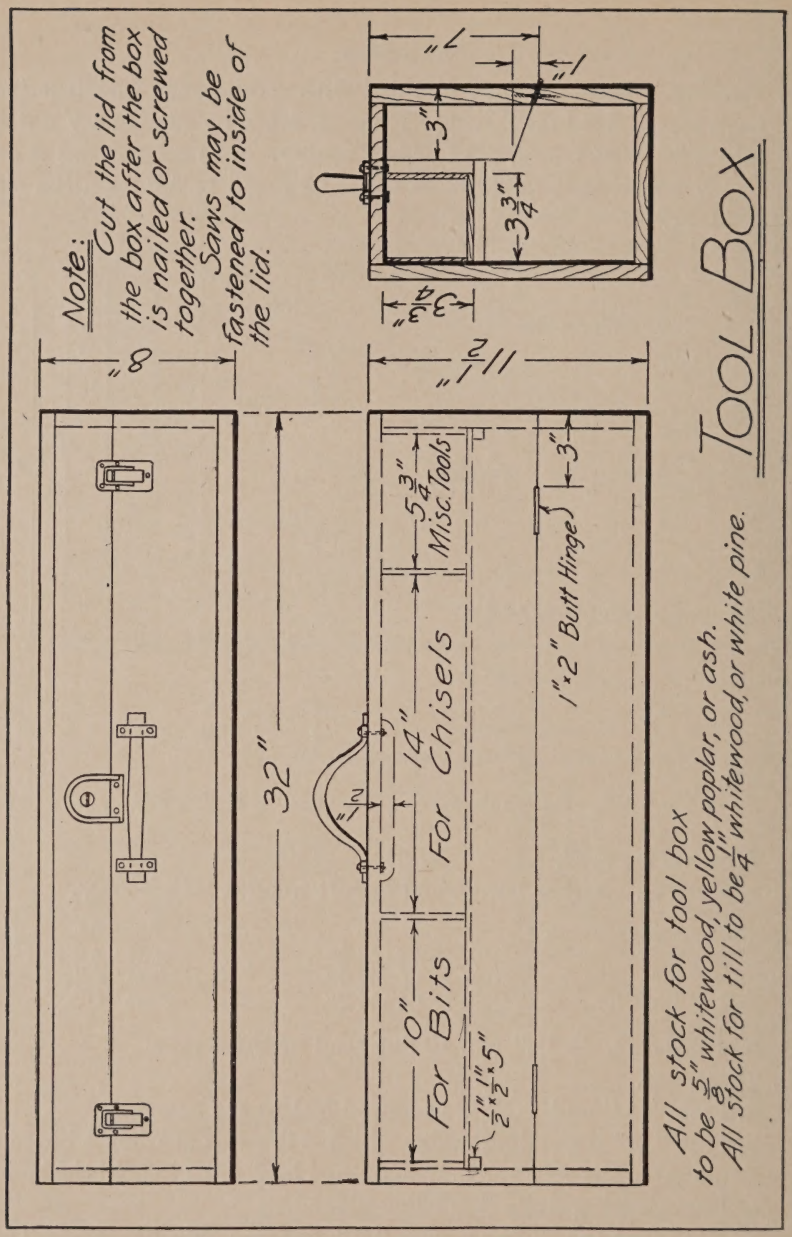

Note: Cut the lid from the box after the box is nailed or screwed together. Saws may be fastened to inside of the lid.
TOOL BOX
8"
11 1/2"
1"
3"
3 3/4"
3 1/4"
32"
14"
For Chisels
5 3/4" Misc. Tools
3"
1"x2" Butt Hinge
10"
For Bits
1 1/2"x2 1/2"x5"
All stock for tool box to be 5/8" whitewood, yellow poplar, or ash.
All stock for till to be 1/4" whitewood, or white pine.

FIG. 234. TOOL BOX

Tool Box

1. *Purpose.* This tool box is of the suitcase pattern, and is extensively used by persons who want a tool box that will hold quite a few tools, and that can be carried around easily.

The inside length of the box is made such that it will hold the hand saws.

2. *Material required.*

a. *Lumber.* Whitewood, yellow poplar, or ash.

No. of Pieces	Dimensions	Purpose
1	$\frac{5}{8}'' \times 11\frac{1}{2}'' \times 32''$	Front
1	$\frac{5}{8}'' \times 11\frac{1}{2}'' \times 32''$	Back
1	$\frac{5}{8}'' \times 6\frac{3}{4}'' \times 32''$	Top
1	$\frac{5}{8}'' \times 6\frac{3}{4}'' \times 32''$	Bottom
2	$\frac{5}{8}'' \times 6\frac{3}{4}'' \times 10\frac{1}{4}''$	Ends
1	$\frac{1}{4}'' \times 3\frac{3}{4}'' \times 30\frac{3}{4}''$	Bottom of till
2	$\frac{1}{4}'' \times 3\frac{1}{2}'' \times 30\frac{3}{4}''$	Sides of till
4	$\frac{1}{4}'' \times 3\frac{1}{4}'' \times 3\frac{1}{2}''$	Partitions and ends of till

b. *Hardware.*

1 suitcase lock.
2 suitcase hasps.
1 suitcase handle.
4 $\frac{1}{4}'' \times 1\frac{1}{2}''$ carriage bolts or soft steel rivets for handle.
2 $1'' \times 2''$ butt hinges with screws.
$\frac{1}{4}$ lb. 1″ wire brads.
6 doz. $1\frac{1}{4}''$ No. 8 round-head blued screws or $\frac{1}{2}$ lb. 6d. finishing nails.

c. *Varnish.* A small amount of stain, and shellac, or better, spar varnish.

3. *Directions.*

a. The construction is quite simple. The box is nailed or screwed together and the lid is then cut out of it.

b. Care should be taken that screws or nails are not placed where saw-kerfs are to be made.

c. The box can be attractively fastened together by using round-head screws either in the blue finish, or in solid brass. A satisfactory job can also be made by using nails. These are set and the holes puttied.

d. A removable till can also be placed in the bottom of the tool box.

e. Brass corners would add to the strength and appearance of the box.

f. Stain the box, and finish with two coats of spar varnish. Apply this in a room having a temperature of about 70 degrees, and where there is no dust.

Tool Chest

1. *Purpose.* This tool chest is for use around the farmstead. It is somewhat smaller than carpenters usually build. If one has, or expects to have, a large kit of tools it will be well to make the chest 2″ higher, 4″ wider, and 6″ longer.

2. *Material required.*

a. *Lumber.* Either soft or hard wood of good quality.

No. of Pieces	Dimensions	Purpose
1	$\frac{5}{8}'' \times 11\frac{1}{2}'' \times 26\frac{3}{4}''$	Bottom
2	$\frac{5}{8}'' \times 9\frac{1}{4}'' \times 26\frac{3}{4}''$	Sides
1	$\frac{5}{8}'' \times 11\frac{1}{2}'' \times 26\frac{3}{4}''$	Top
2	$\frac{5}{8}'' \times 3'' \times 28''$	Trim for sides
2	$\frac{5}{8}'' \times 2'' \times 28''$	Trim for sides
2	$\frac{5}{8}'' \times 1'' \times 28''$	Trim for lid
2	$\frac{5}{8}'' \times 3'' \times 28''$	Trim for ends
2	$\frac{5}{8}'' \times 2'' \times 12\frac{3}{4}''$	Trim for ends
2	$\frac{5}{8}'' \times 2'' \times 12\frac{3}{4}''$	Trim for lid
2	$\frac{5}{8}'' \times 2'' \times 10''$	Cleats for lid

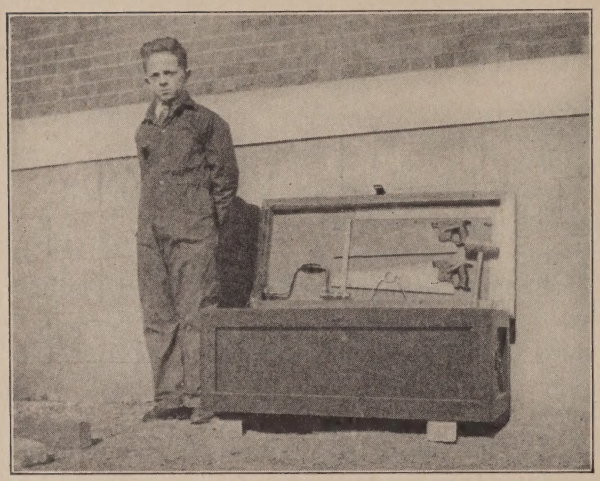


Fig. 235. Tool Chest built by Orval Dick (Fifteen Years Old)

Crawford County, Kansas, High School. Photograph, courtesy of Mr. Wm. R. Curry, Supervisor of Agricultural Education, State Department of Education, Topeka, Kansas.

b. *Hardware.*
8 1½" No. 8 round-head blued screws.
¼ lb. 6d. finishing nails.
¼ lb. 8d. finishing nails.
1 chest hasp and staple plate.
1 pair of chest handles.
4 ¾" gliders.
1 pair butt hinges 2½" long, with screws.

c. *Paint.* A small amount of paint.

3. *Directions.*
   a. Note that no allowance was made for tills for this chest.
   b. All lumber should be well seasoned, and smoothed by hand before assembling the chest.
   c. Fasten the bottom to the sides by nailing through the bottom into the sides.
   d. Miter the base trim around the box. Nail or screw it fast.
   e. Miter the upper trim around the box.
   f. Fit and hinge the cover.
   g. The entire top is sometimes covered with sheet metal such as zinc. This makes the chest water proof.
   h. If the box is to be made larger, all material should be $\frac{13}{16}''$ instead of $\frac{5}{8}''$ thick.
   i. Paint the chest, or stain and varnish it.

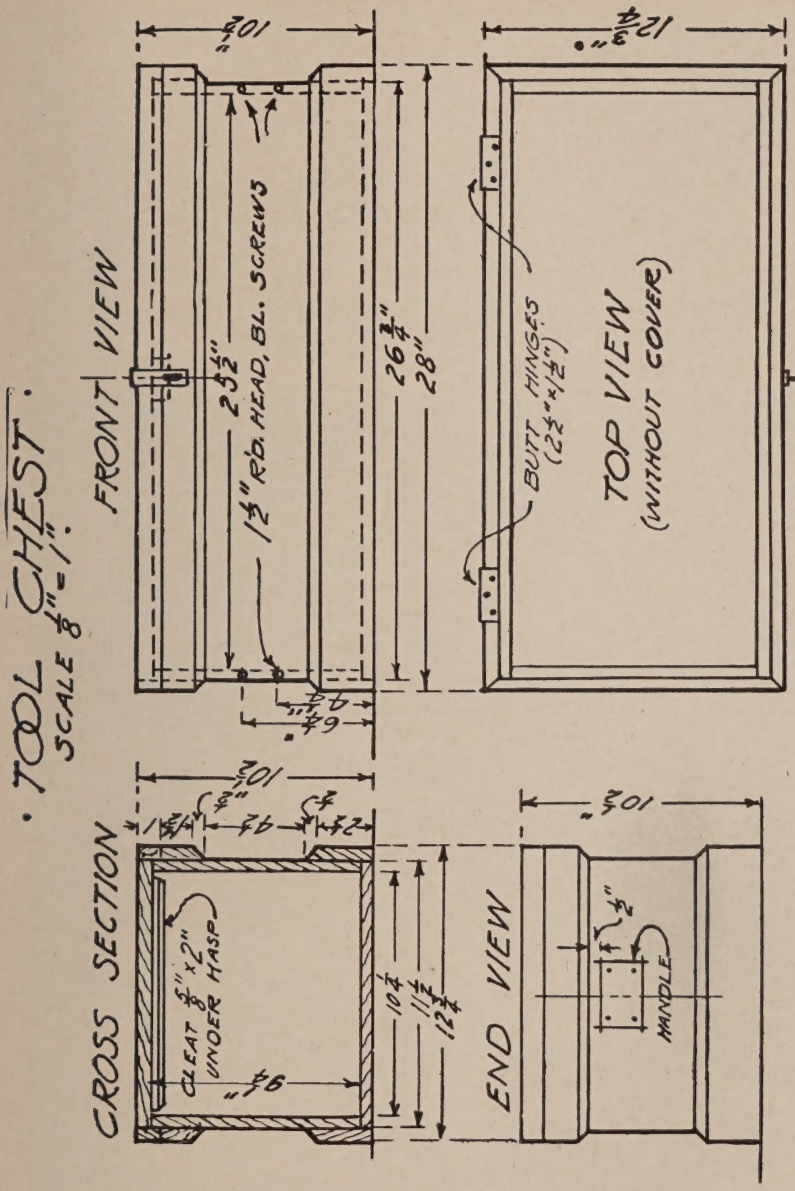


FIG. 236. TOOL CHEST

Drawing-Board Support

1. *Purpose.* Many times, especially in rural schools, there are no separate drawing tables, nor is there space for such tables. The drawing-board support shown herewith is made so that it will fit into any ordinary bench vise. This makes it possible to do shop sketching and mechanical drawing right in the shop.

The support may be adjusted for height to suit the pupils, and

is easily taken out of the way when not in use. A stool can be used in connection with this drawing-board support.

2. *Material required.*

a. *Lumber.* White pine, or similar lumber.

No. of Pieces	Dimensions	Purpose
1	$^{13}/_{16}'' \times 13'' \times 18''$	Front
2	$^{13}/_{16}'' \times 1\frac{1}{2}'' \times 17''$	Front cleats
2	$^{13}/_{16}'' \times 2'' \times 20''$	Arms
2	$^{13}/_{16}'' \times {}^{13}/_{16}'' \times 2\frac{1}{2}''$	End blocks
2	$^{13}/_{16}'' \times 1\frac{1}{2}'' \times 14\frac{3}{4}''$	Braces

b. *Hardware.*

12 1¼″ No. 8 round-head blued screws.

12 6d. finishing nails.

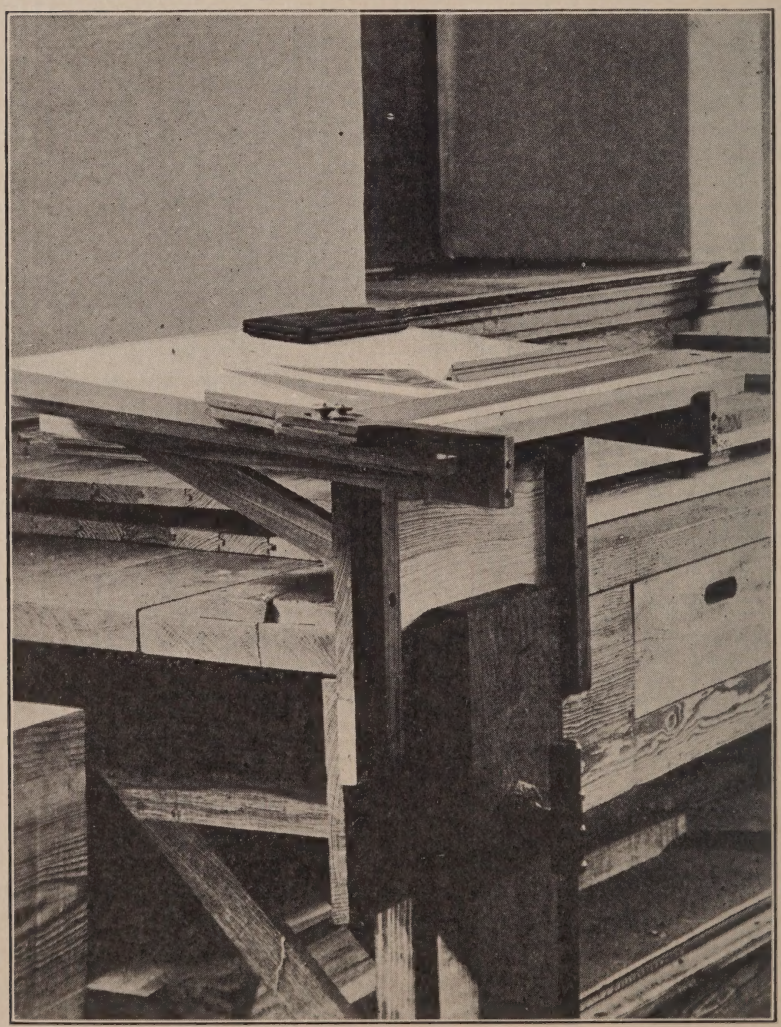


Fig. 237. Drawing-Board Support for Shop Benches

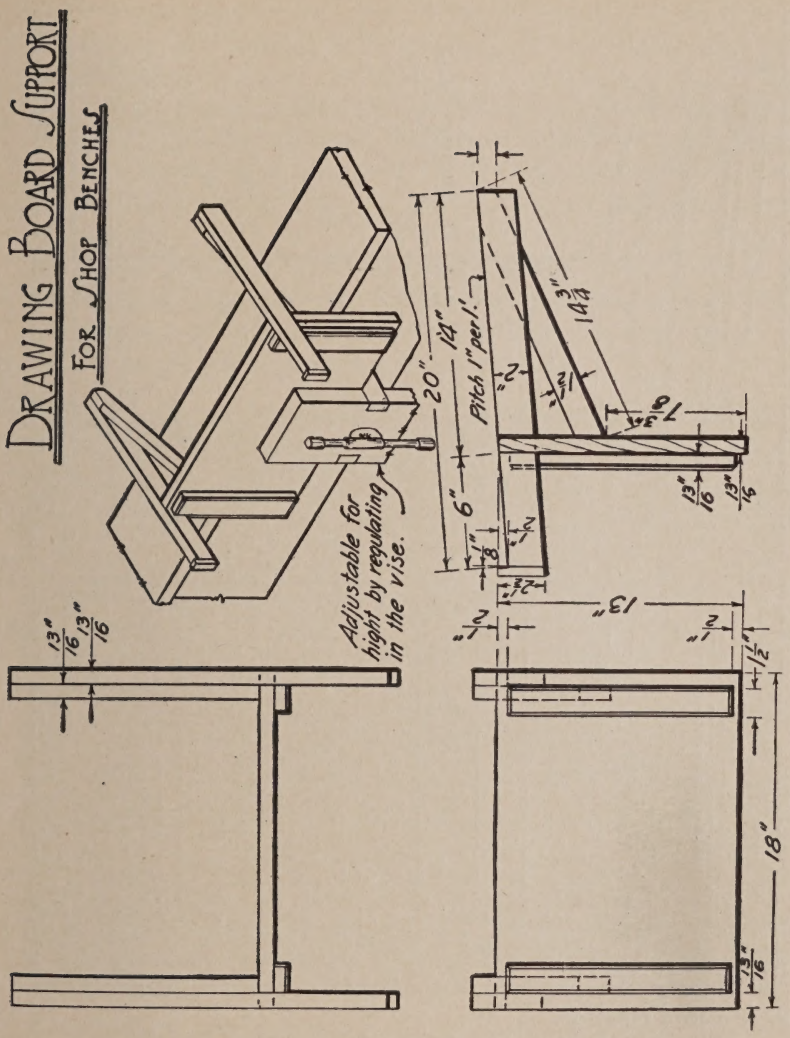


FIG. 238. DRAWING-BOARD SUPPORT FOR SHOP BENCHES

3. *Directions.*
   a. Fit the cross-arms and braces to the front board.
   b. Nail the braces through the front board and then fasten cleats to front board to stiffen same and keep it from warping.
   c. Finish with linseed oil, shellac, or varnish.

Drawing Table

1. *Purpose.* This drawing table is easily made, and is adapted to the schoolroom, shop, or home where drawings are made. Notice that the top is made by screwing a drafting board — which can usually be purchased more satisfactorily than it can be made by hand — to the skeleton framework of the table.

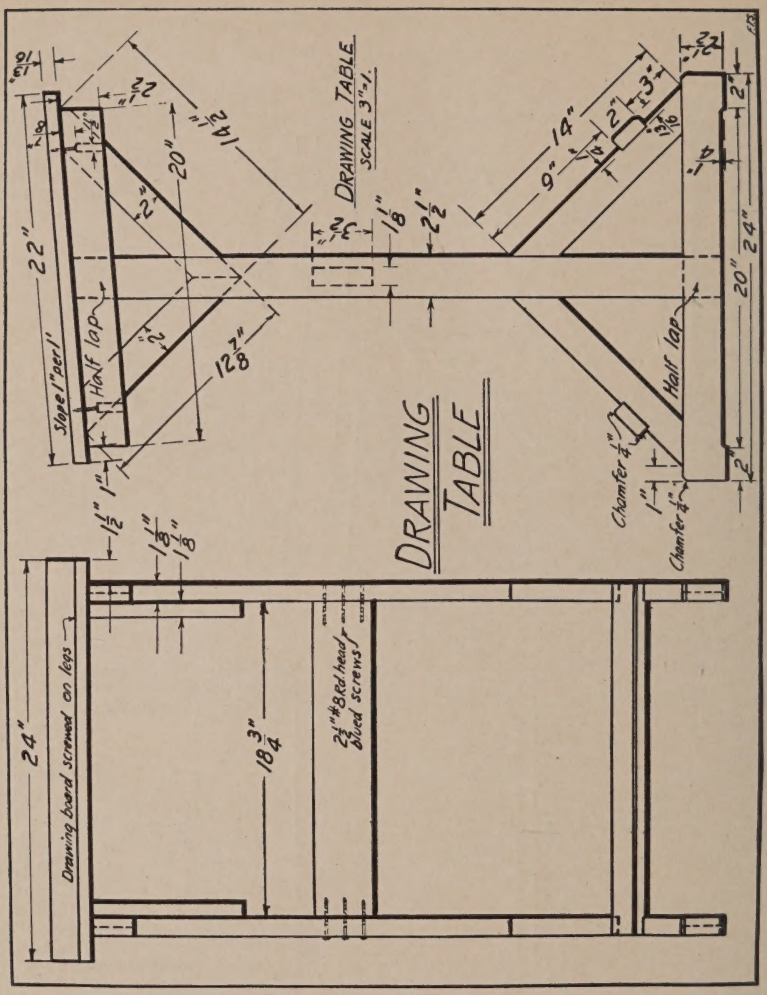


FIG. 239. DRAWING TABLE

2. *Material required.*

a. *Lumber.* White pine, fir, or yellow poplar.

No. of Pieces	Dimensions	Purpose
2	1⅛″ × 2½″ × 24″	Lower cross-ties
2	1⅛″ × 2½″ × 20″	Upper cross-ties
2	1⅛″ × 2½″ × 3′ 2″	Uprights
4	1⅛″ × 2″ × 1′ 2″	Lower braces
2	1⅛″ × 2″ × 12⅞″	Upper braces
2	1⅛″ × 2″ × 14½″	Upper braces
1	1⅛″ × 3½″ × 18¾″	Central tie
2	1⅛″ × 2″ × 21″	Foot rests
1 soft white pine drawing board 2″ × 24″		

b. *Hardware.*

6 2½″ No. 8 round-head blued screws (or ¼″ × 3″ lag screws).

4 1½″ No. 8 flat-head bright screws.

¼ lb. 6d. finishing nails.

¼ lb. 8d. finishing nails.

3. *Directions.*

a. Fasten each upright to its top and bottom cross-tie, and fasten the braces in place.

b. Lay one upright with braces attached over the other one to see that they are alike before starting to erect the separate parts.

c. The lower cross-ties have ¼″ of material removed along most of the lower edge in order that the table may stand well on uneven flooring.

d. Fasten the lower braces by toe-nailing.

e. Bore ½″ holes about 1¾″ deep into the upper cross-ties so that screws may be placed therein to catch the drawing board.

f. Finish with linseed oil, shellac, or varnish.

FIG. 240. PROJECTS WORKED OUT BY PUPILS AT TOWANDA, PA.
Mr. B. A. Rockwell, instructor. Photograph, courtesy of B. A. Rockwell.

REFERENCES

Blackburn, Samuel A. *Farm Woodworking.* Manual Arts Press.
Brace, George M., and Mayne, D. D. *Farm Shop Work.* American Book Co.
Burton, Myron G. *Shop Projects Based on Community Problems.* Vocational Supply Co., Muncie, Ind.
Griffith, Ira. *Carpentry.* Manual Arts Press.
Radford, Wm. A. *Practical Carpentry.* Radford Architectural Co.
Roehl, Louis M. *Agricultural Woodworking.* Bruce Publishing Co.
Roehl, Louis M. *Farm Woodwork.* Bruce Publishing Co.

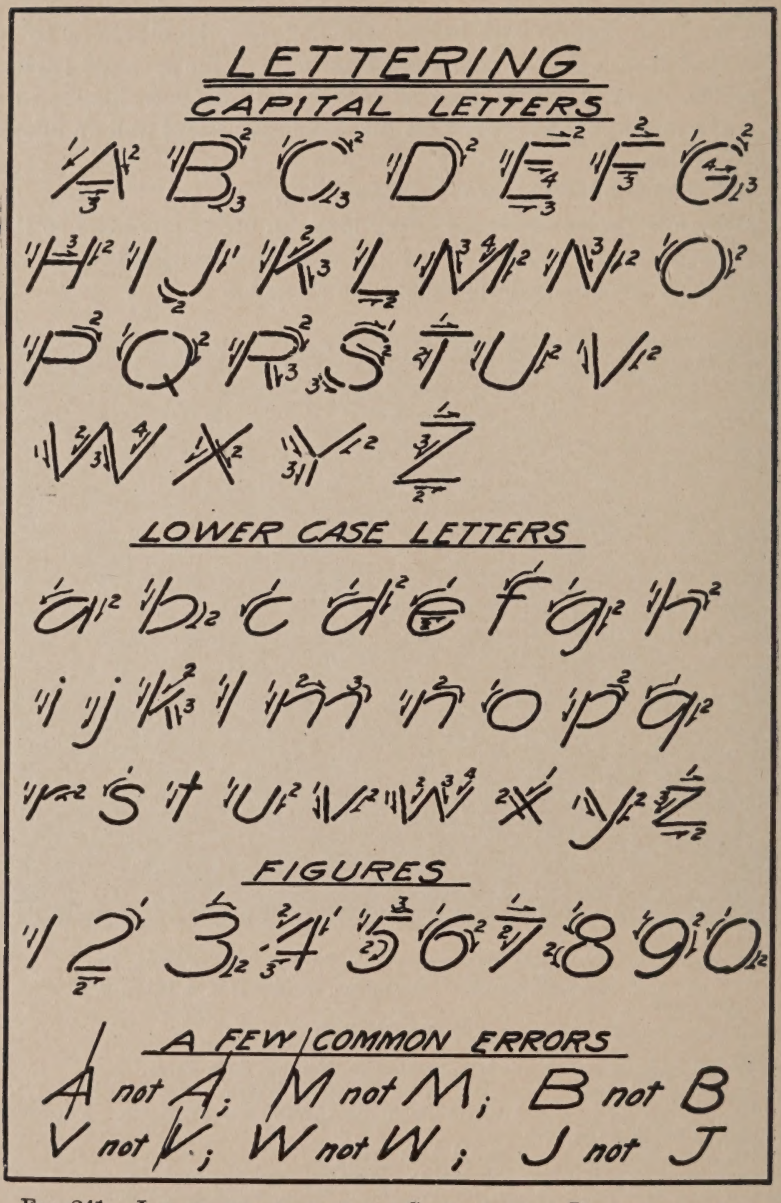


FIG. 241. LETTERING, SHOWING THE SEQUENCE AND DIRECTION OF THE VARIOUS STROKES

CHAPTER XVII

SKETCHING AND MECHANICAL DRAWING

SKETCHING is a universal language that is helpful to all who deal directly and indirectly with tools and materials. If a farmer can make a sketch of a part of a tool or machine that needs to be repaired or of some object that needs to be made, let us say in a garage or a machine shop, he can send the sketch there and the object can be made without difficulty. It is likewise desirable that farmers know how to read working drawings of any kind. The extent to which mechanical drawing should be taught to agricultural students is debatable. It is felt that the following abilities should be developed in agricultural students in the approximate order in which they follow:

1. To read working sketches and blue-prints.
2. To make working sketches. (These not to be to scale, but must show all necessary views, dimensions, and explanatory notes.)
3. To make out bills of material, and write simple, accurate specifications to accompany and amplify the sketches.
4. To make working drawings to scale, in pencil.
5. To make working drawings to scale, in ink, to make tracings, and blue-prints.

It may not be advisable to carry all pupils studying vocational agriculture through each of the five steps enumerated.

Reading Working Drawings

1. *Purpose.* It is sometimes advisable to learn to read blue-prints and other forms of working drawings without actually doing any drawing. This can easily be done by learning a few fundamental facts about how objects are represented on paper by draftsmen.
2. *Lettering.* Several standard styles of letters are used. Fig. 241 shows one of the best styles used by mechanical draftsmen. It is called the "inclined single-line Gothic." The same figure shows the directions and sequence of the various strokes that make up the letters and numerals.

   The same style of letter is shown in Fig. 242. Notice the slope, and the proportions of the letters.
3. *Conventional lines.* Six different kinds of lines are shown in Fig. 243. Each line is made in a special way and has a standard use and interpretation. The conventions shown are widely used. By learning what each kind of line stands for, one may easily read drawings that are made in conformity with standard conventions. The conventions used by persons in various sections of the country are so

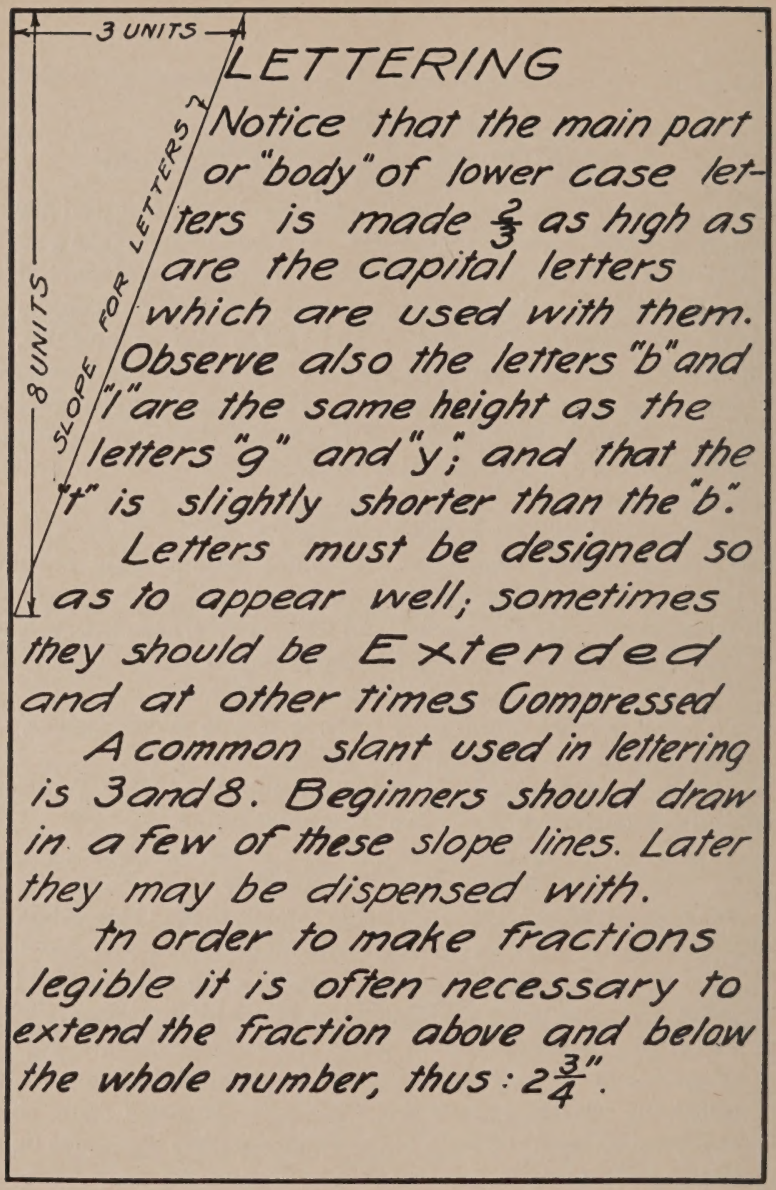

3 UNITS
8 UNITS
SLOPE FOR LETTERS
LETTERING
Notice that the main part or "body" of lower case letters is made ⅔ as high as are the capital letters which are used with them. Observe also the letters "b" and "l" are the same height as the letters "g" and "y"; and that the "t" is slightly shorter than the "b".
Letters must be designed so as to appear well; sometimes they should be Extended and at other times Compressed
A common slant used in lettering is 3 and 8. Beginners should draw in a few of these slope lines. Later they may be dispensed with.
In order to make fractions legible it is often necessary to extend the fraction above and below the whole number, thus: 2 3/4".

FIG. 242. LETTERING, SHOWING THE PROPER SLOPE AND PROPORTION FOR THE VARIOUS LETTERS

nearly the same that little difficulty is experienced in reading drawings.

4. *Conventional sectioning.* In order that it may be easy to distinguish the kinds of materials used, there have been evolved certain standard ways of representing these materials. The conventional sec-

tioning shown in Fig. 244 shows how to represent a number of kinds of materials.

5. *Orthographic projections.* By projection is meant the way the object is represented on the paper. Probably over ninety per cent of all working drawings that are used are made in accordance with the principles of what is technically called orthographic projection.

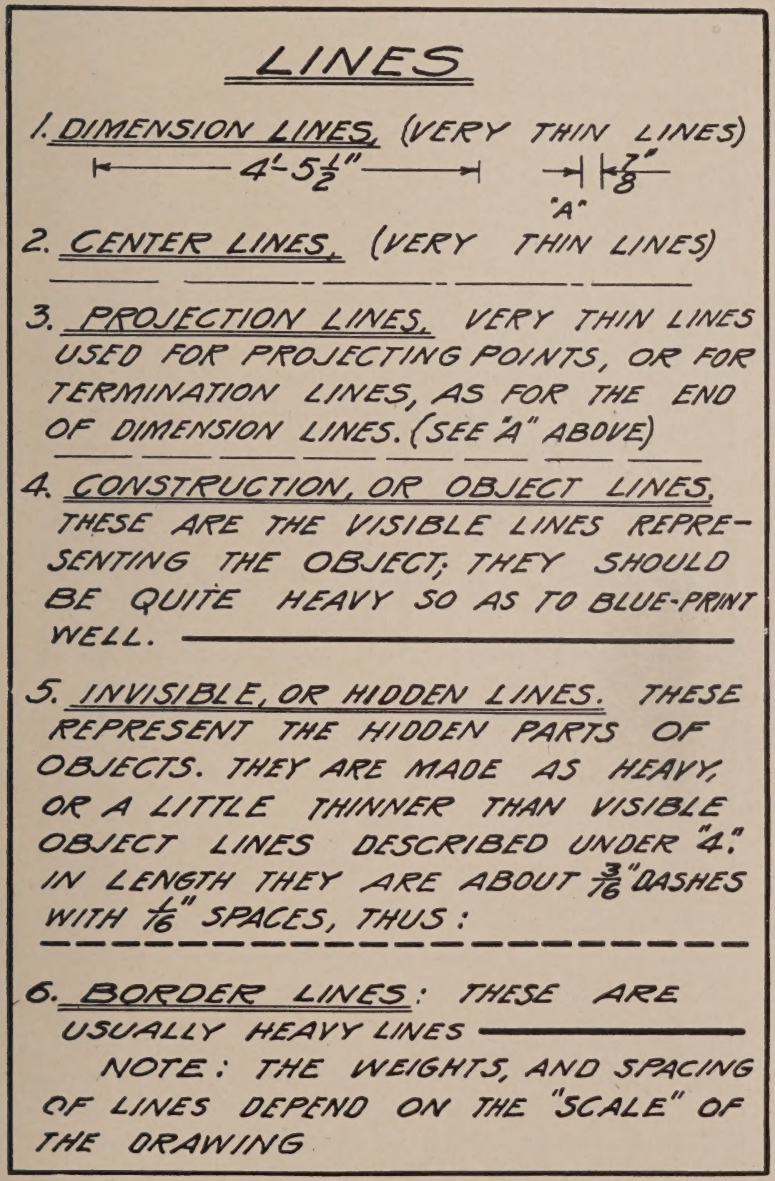

LINES
1. DIMENSION LINES, (VERY THIN LINES)
4'-5 1/2"
7/8"
"A"
2. CENTER LINES, (VERY THIN LINES)
3. PROJECTION LINES, VERY THIN LINES USED FOR PROJECTING POINTS, OR FOR TERMINATION LINES, AS FOR THE END OF DIMENSION LINES. (SEE "A" ABOVE)
4. CONSTRUCTION, OR OBJECT LINES, THESE ARE THE VISIBLE LINES REPRESENTING THE OBJECT; THEY SHOULD BE QUITE HEAVY SO AS TO BLUE-PRINT WELL.
5. INVISIBLE, OR HIDDEN LINES. THESE REPRESENT THE HIDDEN PARTS OF OBJECTS. THEY ARE MADE AS HEAVY, OR A LITTLE THINNER THAN VISIBLE OBJECT LINES DESCRIBED UNDER "4." IN LENGTH THEY ARE ABOUT 3/16" DASHES WITH 1/16" SPACES, THUS:
6. BORDER LINES: THESE ARE USUALLY HEAVY LINES
NOTE: THE WEIGHTS, AND SPACING OF LINES DEPEND ON THE "SCALE" OF THE DRAWING

FIG. 243. CONVENTIONAL LINES

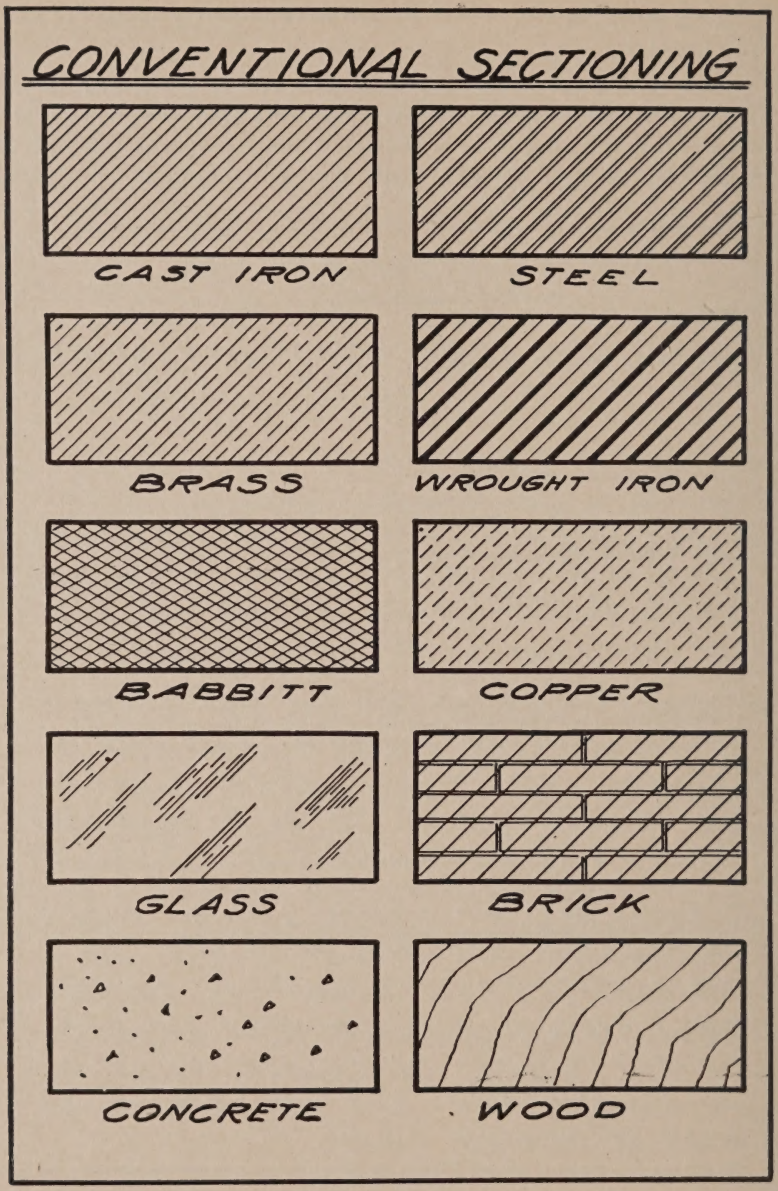


FIG. 244. CONVENTIONAL SECTIONS

Orthographic drawings show only one side of an object in each view. Two or three different views are used to represent the same object. These views usually have fixed relationship to each other, though circumstances may call for a different arrangement. In standard orthographic drawings, as made in the United States, the top view is shown above the front view and the side view or end

view is usually shown to the right of, and the same height as the front view, as in Fig. 245.

Most of the drawings in this book are examples of orthographic projection.

6. *Isometric projections.* Isometric drawings show three sides or planes in one view. This is of advantage, especially to laymen not

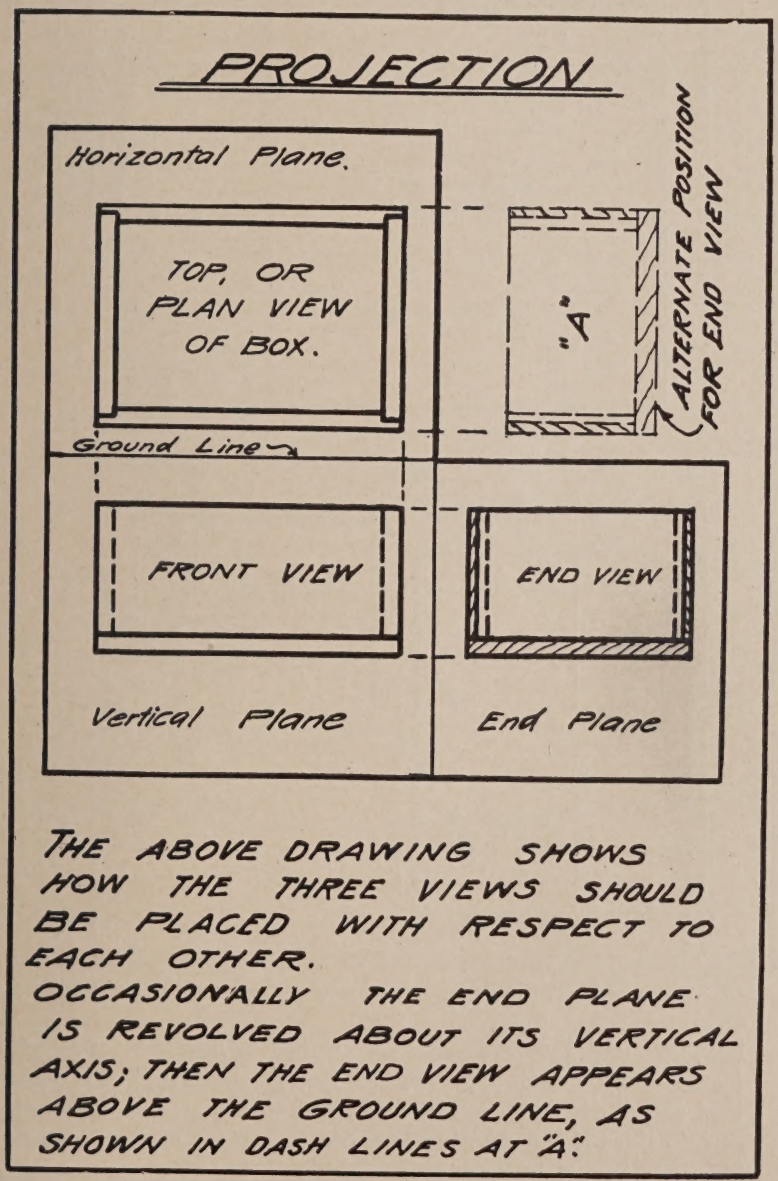

PROJECTION
Horizontal Plane.
TOP, OR PLAN VIEW OF BOX.
"A"
ALTERNATE POSITION FOR END VIEW
Ground Line
FRONT VIEW
END VIEW
Vertical Plane
End Plane
THE ABOVE DRAWING SHOWS HOW THE THREE VIEWS SHOULD BE PLACED WITH RESPECT TO EACH OTHER.
OCCASIONALLY THE END PLANE IS REVOLVED ABOUT ITS VERTICAL AXIS; THEN THE END VIEW APPEARS ABOVE THE GROUND LINE, AS SHOWN IN DASH LINES AT "A".

FIG. 245. ORTHOGRAPHIC PROJECTION

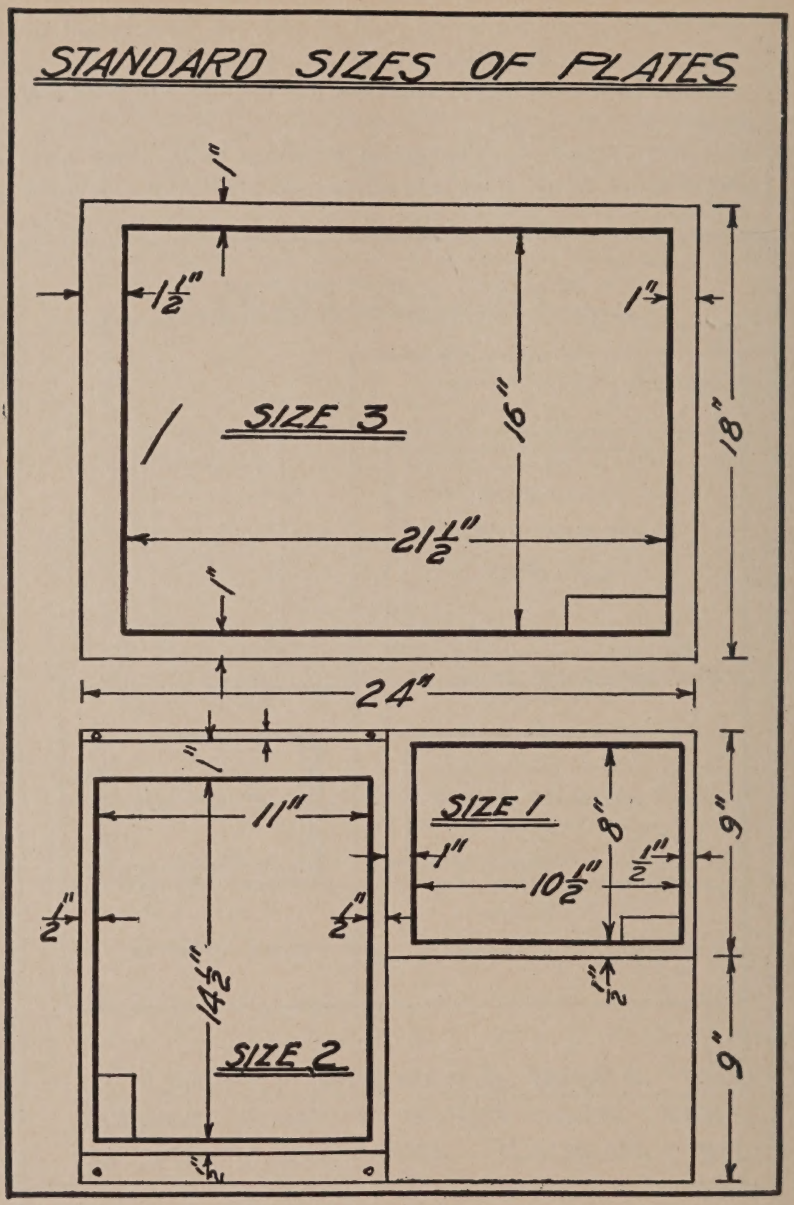


FIG. 246. SIZES OF DRAWING PLATES THAT MAY BE CUT FROM 18" × 24" PAPER

familiar with the principles underlying orthographic projection. Isometric projection approximates true perspective, but is made so that actual distances can be measured on the drawn object, along certain lines if the drawing is made to scale. Figs. 144 and 145 illustrate isometric drawings. Such drawings are easier to make than true perspectives, and are better than the latter when a working drawing is wanted.

7. *Standard sizes of drawings.* Practice differs considerably in the sizes used for drawing plates. Fig. 246 shows how a standard 18″ × 24″ paper may be laid off into three sizes, each a multiple of the other. The plates are laid off with the widest margin at the left hand side, for purposes of binding.

   For class work it is well to require one or more standard sizes for drawings, and a standard title space as shown in Fig. 247.

8. *Pencil or ink.* The time that can be devoted to sketching and to mechanical drawing is so limited in amount that best results can probably be attained by limiting all such work to pencil rendering. Individual pupils who show exceptional interest and capacity may be encouraged to render drawings and tracings in ink.

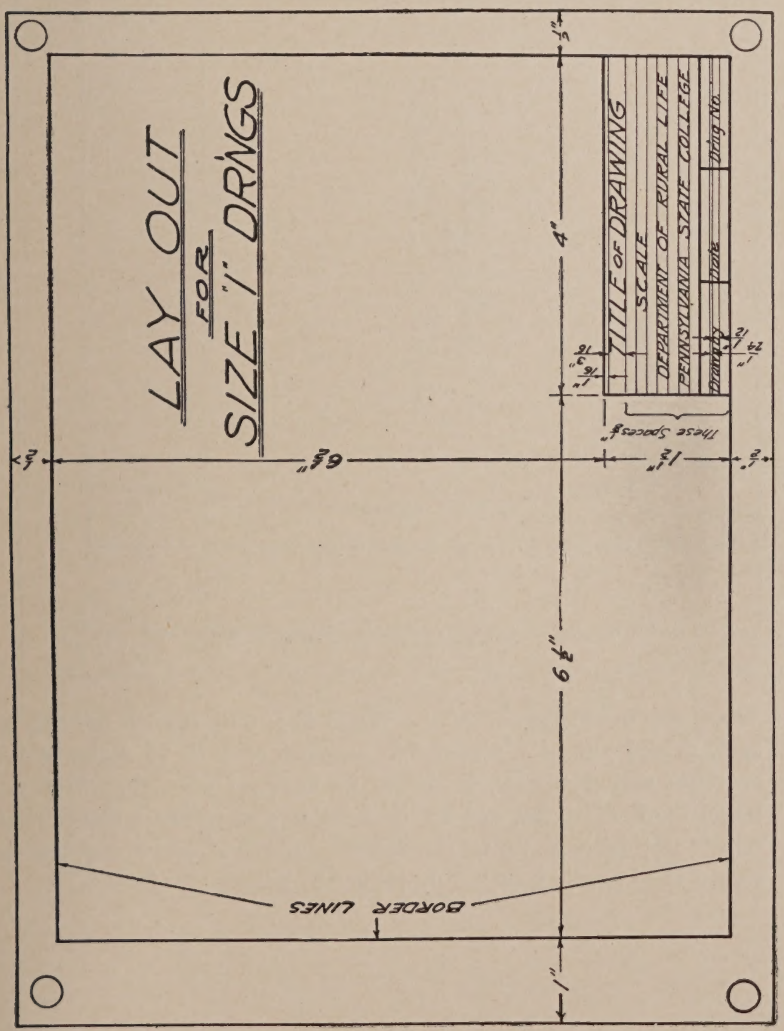


Fig. 247. Layout for Size 1 Drawings

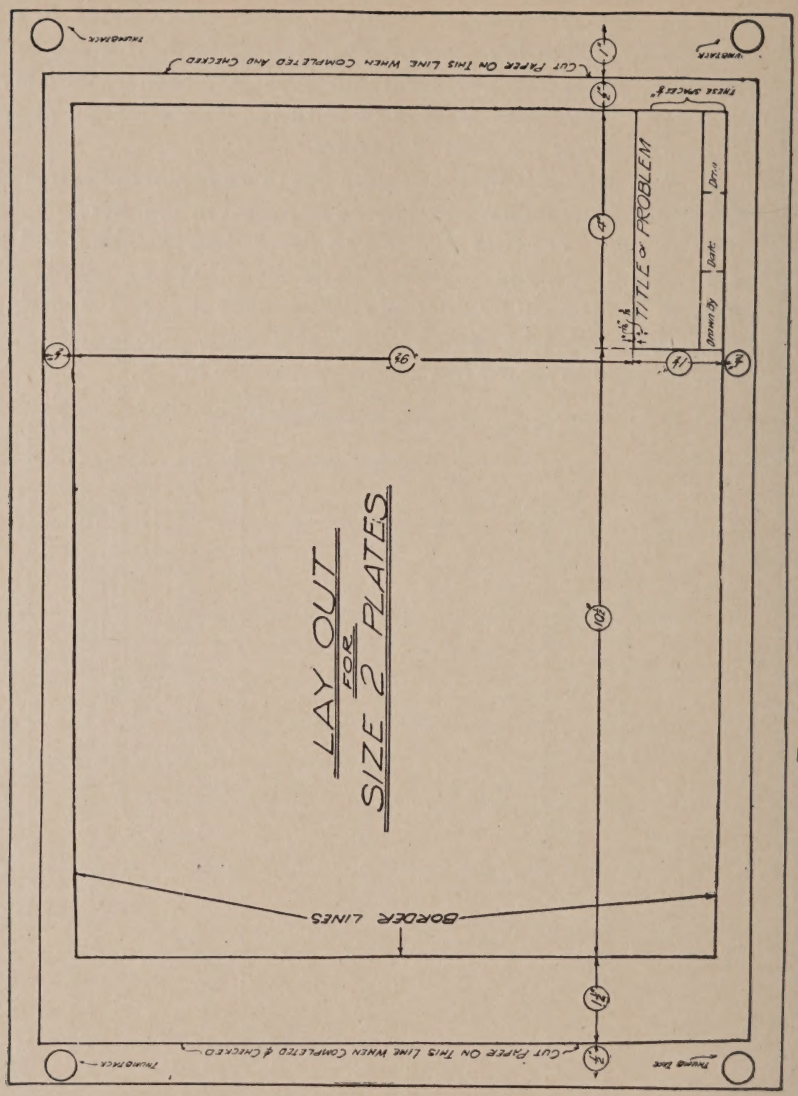


FIG. 248. LAYOUT FOR SIZE 2 DRAWINGS

9. *Technique not the major aim.* While it is desirable to develop in agricultural pupils a reasonable amount of skill to make pencil sketches and drawings, it should be kept in mind that they are preparing for farming and not drafting as a vocation. Hence they should not be held up to the same standard of technique that is expected of pupils that are preparing to become draftsmen.

REFERENCES

Dale, R. Burdette. *Drawing for Builders.* John Wiley & Sons.
French & Svensen. *Mechanical Drawing for High Schools.* McGraw-Hill Book Co.
Hutton, Philip W. *Mechanical Drawing for Industrial and Continuation Schools.* Scott, Foresman & Co.
Leeds, C. C. *Principles of Engineering Drawing for Technical Students.* Van Nostrand Publishing Co.
Mathewson, Frank E. *Perspective Sketching from Working Drawings.* The Taylor-Holden Co.
Mathewson, Frank E. *Applied Mechanical Drawing.* The Taylor-Holden Co.
Reinhardt, C. W. *Lettering for Draftsmen.* Van Nostrand Publishing Co.
Richards, F., and Colvin, F. H. *Practical Perspective.* Henley Publishing Co.
Svensen, C. L. *Essentials of Drafting.* Van Nostrand Publishing Co.
Weick, C. W. *Elementary Mechanical Drawing.* McGraw-Hill Book Co.
Woolley, J. W., and Meredith, R. B. *Shop Sketching.* McGraw-Hill Book Co.
Wyatt, E. M. *Blue-Print Reading.* The Bruce Publishing Co.

CHAPTER XVIII

USES OF ROPE ON THE FARM

1. *Purpose.* Rope is used in so many different ways in connection with farm shop work that a working knowledge of the characteristics of rope, and an understanding of how to make a limited number of knots, hitches, and splices, is essential to efficient farming.
2. *Kinds of rope.* The two materials most commonly used in the manufacture of ropes used on the farm are manila hemp and sisal. The latter is cheaper than good grade manila hemp, is harsher, and not so strong. Most of the binder twine is made of sisal fiber. For the heavier ropes manila hemp is strongest and best.
3. *Standard size, weight, and strength of rope.* Rope is usually sold by the pound, and purchased by farmers by the foot. Table 18 shows the weights of given lengths of rope, and also shows the breaking strength as well as the safe working strength. The latter is much less as the safe working strength is only about ⅙ of the actual breaking strength of good quality rope. Such factors of safety must always be allowed in order to provide for possible defects in workmanship and for variations in the strength of fiber.

TABLE 18. DATA ON THREE-STRAND MANILA ROPE [1]

DIAMETER (inches)	WEIGHT OF 100 FEET OF ROPE (pounds)	ULTIMATE TENSILE STRENGTH (pounds)	SAFE LOAD (pounds)
¼	3	400	55
⅜	5	900	130
½	7⅔	1620	230
⅝	13⅓	2880	410
¾	16⅓	3640	520
⅞	22⅔	5440	775
1	28⅓	6480	925
1¼	45	10120	1445
1½	65	14600	2085
1¾	97	21500	3070
2	113	25200	3600

[1] Computed from formula of C. W. Hunt.

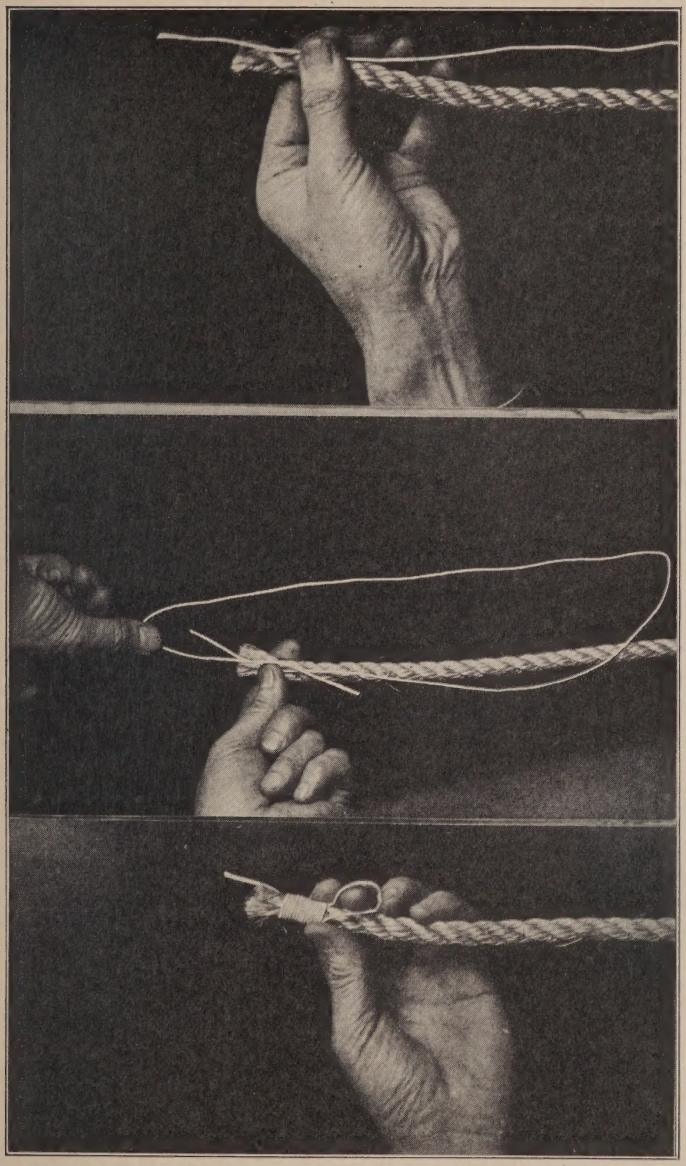


FIG. 249. WHIPPING THE END OF A ROPE (FIRST THREE STEPS)

Photograph reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

4. *Care of rope.* Repeated drying and wetting has a harmful effect upon rope. When not in use, ropes should be dried thoroughly, and should be kept in a dry place.

Whipping the End of a Rope

1. *Purpose.* In order to keep the ends of ropes from fraying, and in order that they may readily pass through pulleys, rings, or other small openings, the ends are wrapped as shown in Figs. 249 and

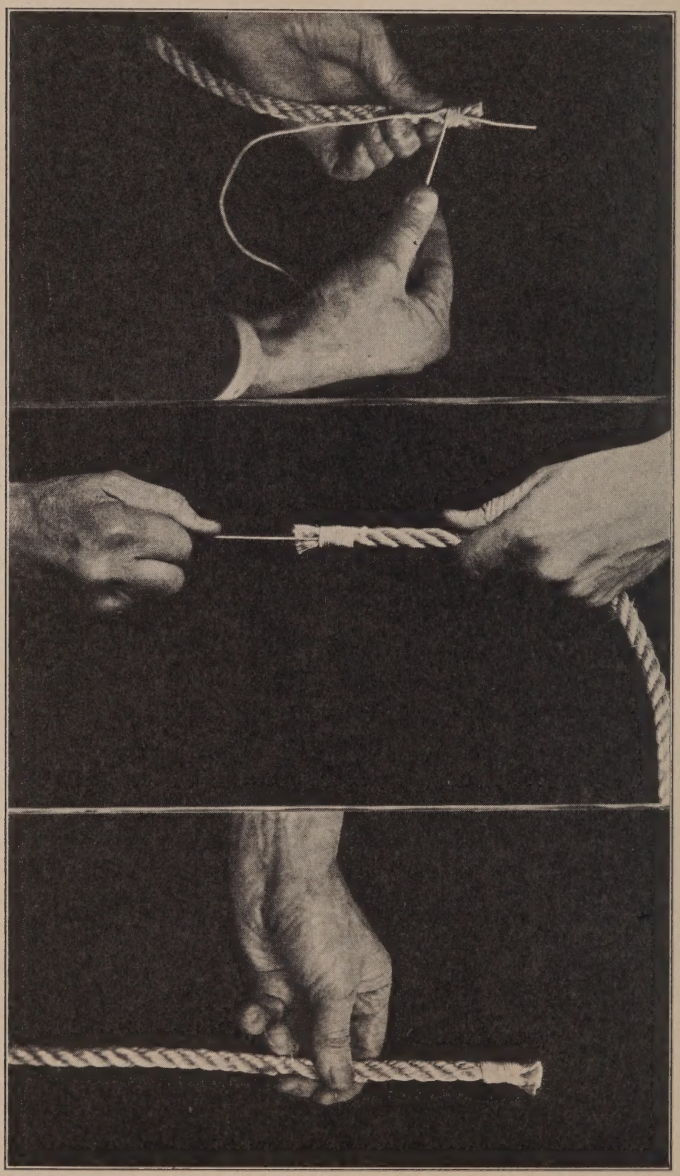


FIG. 250. WHIPPING THE END OF A ROPE (FINAL STEPS)

Photograph reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

250. This is technically called "whipping." Another method of whipping the end of a rope is shown in Fig. 251.

2. *Directions.*
   a. Take a piece of string about 3′ long and wax it with shoemaker's wax or beeswax.
   b. Lay a loop along the end of the rope as shown at No. 1, letting the short end of the cord "A" extend about 3″ from the rope.
   c. Wrap the long end "B" tightly around the rope in such a way that there is no space between the cord wrappings. Continue until only ½″ of the end of the rope remains unwrapped.

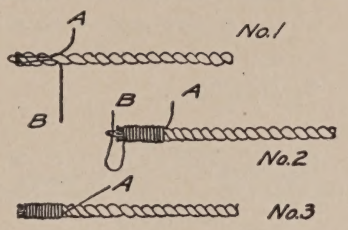


Fig. 251. One Method of Whipping the End of a Rope

   d. Pass the end "B" through the loop at the end of the cord.
   e. Grasp the end "A" and pull the end "B" as far as possible under the wrapping.
   f. What remains of ends "A" and "B" may be cut off close to the rope.

Knots

1. *Characteristics.* Knots differ greatly in the following respects:
   a. Speed with which they can be tied.
   b. Speed with which they can be untied.
   c. Holding power.
2. *Elements.* Knots are made up of loop, bights, and turns. In Fig. 252 "A" represents a loop or open bight. It is made by turning the rope back upon itself. A bight is shown at "B," and a round turn at "C." The part of the rope "D" opposite to the end "A" is called the "standing part." As these terms are used in describing the construction of knots and hitches it is advisable to be familiar with them.

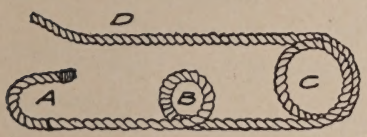


Fig. 252.

A. End. *B.* Loop. *C.* Bight. *D.* Standing Part.

The Overhand Knot

1. *Purpose.* The overhand knot is the simplest that can be made. It is used at the end of ropes to keep the ends from unlaying, and is also used in other parts of the rope as a stopper knot. The overhand knot forms a part of many other knots.

Fig. 253. The Overhand Knot

2. *Directions.* The standing part "B" is held in the left hand. The end "A" is passed through the loop thus formed, and is pulled tight.

The Square Knot

1. *Purpose.* The square knot is used more frequently than any other for tying together two ropes, cords, or strings of equal diameter; the knot will hold well and is easy to untie. Variations of it, such as the square knot with a single bow, and the square knot with the double bow are used in tying shoe-laces.
2. *Directions.*

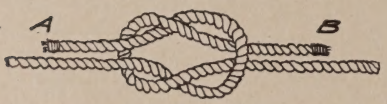


FIG. 254. THE SQUARE KNOT

a. Tie the right-hand form of the overhand knot.
b. Cross the ends "A" and "B" and tie the left-hand overhand knot.
c. Notice that the standing part and the end of each rope is passed through the loop formed by the other rope. (Fig. 254.)
d. A false and unsatisfactory form of the square knot is called the "granny" or "lubber's" knot. Notice the construction carefully so that the true square knot shown in Fig. 254 will be made.

The Weaver's Knot

1. *Purpose.* This knot derives its name from the fact that weavers use it in tying yarn or threads that break in the loom. It is used by

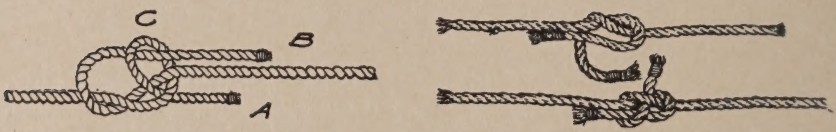


FIG. 255. SHOWING ONE WAY OF TYING THE WEAVER'S KNOT

Reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

farmers in tying binder twine because the knot can be made easily so that both ends of the knot point in the same direction. This is

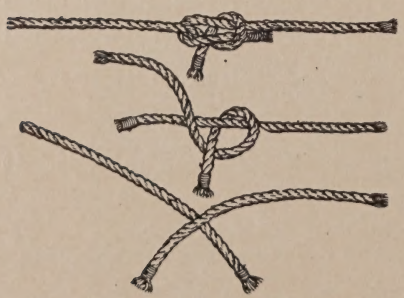


FIG. 256. SHOWING ONE WAY OF TYING THE WEAVER'S KNOT

Reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

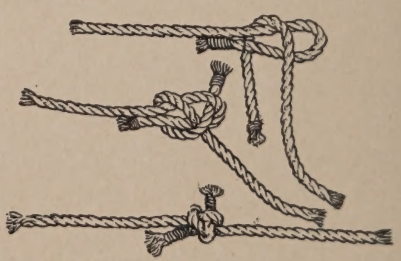


FIG. 257. SHOWING STEPS IN TYING A KNOT THAT IS SIMILAR TO THE WEAVER'S KNOT

Reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

useful when the knot has to pass through openings such as the eye of a needle.

2. *Directions.*
   a. Make the bight "B" (Fig. 255) at the end of one of the ropes.
   b. Take the end "A" of the other rope and pass it through the bight formed with the end "B."
   c. Complete the knot by throwing the loop "C."

Slip Knot

1. *Purpose.* The slip knot is the most common form of an eye knot. It is used where a loop is wanted that will slip out tight against an object. This knot is difficult to untie if it is pulled tight.

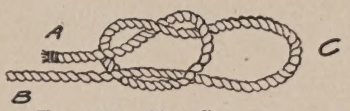


FIG. 258. THE SLIP KNOT

2. *Directions.*
   a. Form a bight "C" (Fig. 258).
   b. With the end "A" make an overhand knot around the standing part "B."

The Bowline Knot

1. *Purpose.* The bowline knot is one of the most useful, and at the same time least understood knots among laymen. It derives its name from the fact that sailors use it in mooring their ships by means of a line from the bow of the vessel.

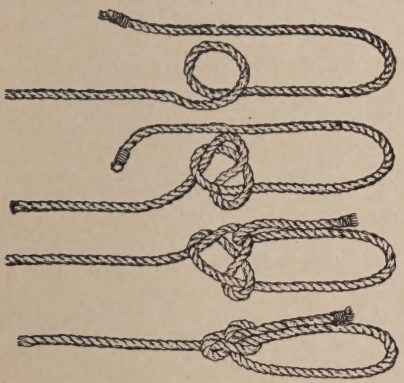


FIG. 259. SHOWING ONE METHOD OF TYING THE SINGLE BOWLINE KNOT

Reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

The bowline is sometimes called "the king of knots." It is easily tied, it will not slip or draw tight, and can be untied easily. It is used in various kinds of construction work. Farmers find it an excellent knot when a loop is wanted in the end of rope. For example, it is used to advantage in tying a rope through the clevis of a doubletree, or through the ring of a singletree. It is the safest knot to use when a rope is placed around a person's body, or around an animal's neck.

2. *Directions.* There are several ways of making the bowline knot, and several variations of the knot. A simple method is shown in Fig. 260. It is made as follows:

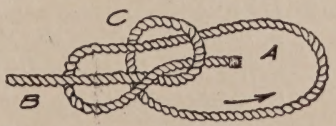


FIG. 260. THE SINGLE BOWLINE KNOT

a. Throw the bight "C."

b. Grasp this with the left hand. With the right hand pass the end "B" through the bight around the standing part "B," and back through the bight "C."

The Double Bowline

1. *Purpose.* The double bowline is used when a loop is wanted in some part of rope other than at the end. It is also used in tying loops at the ends of thin ropes when they are used double.
2. *Directions.* The same method is used as with the single bowline knot, the difference being that the double bowline is tied after the rope has been doubled.

Halter Tie

1. *Purpose.* This knot is used to tie farm animals to posts, or to rings. The knot can be untied easily by jerking the end of the rope, and yet may be made tight enough to keep it from slipping down the post to which it may be tied. This is essential, as the animal might otherwise get a foot over the halter rope.

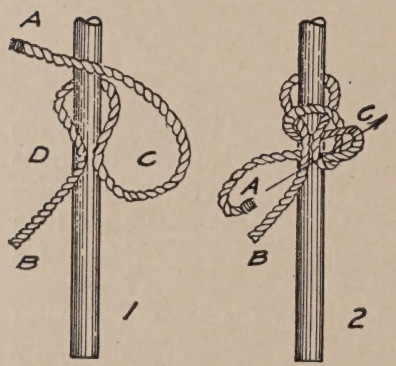


FIG. 261. THE HALTER TIE

2. *Directions.*
   a. Pass the rope around the post. Hold the standing part at "D" No. 1 (Fig. 261) with the left hand.
   b. With the right hand form a bight at "C."
   c. Pull a loop, formed with the end "A," through the bight "C."
   d. Pass the end of the rope "A" through the loop at "C" (No. 2) in order to keep the knot from becoming untied.

Grainsack or Miller's Knot

1. *Purpose.* This knot is used on the farm to tie up grain sacks or other farm produce. Strictly speaking it is not a knot but a form of clove hitch. The method of tying the knot is shown in Fig. 262.
2. *Directions.*
   a. Bring the end of the string "A" around the top of the sack passing it under the end "B" and then over the end "B."
   b. Again bring the end of the string "A" around the top of the sack in such a way as to pass over the end "B" and then through the loop "C."

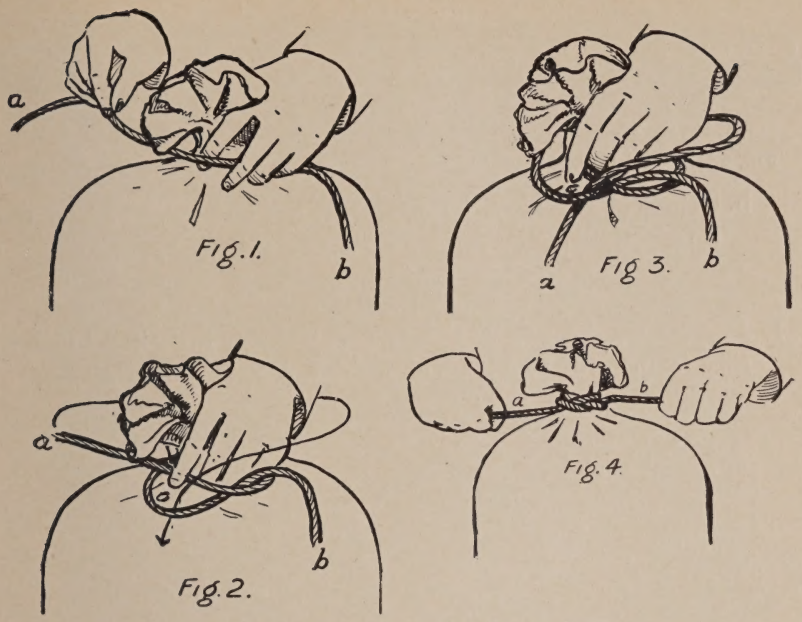


FIG. 262. STEPS IN TYING THE MILLER'S KNOT

Reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

c. Complete the knot by pulling on the ends.

d. To loosen the knot give the end "A" a quick upward jerk.

The Half Hitch

1. *Purpose.* The half hitch is used where a steady stress or pull is to be exerted, and where a temporary hitch is desired.
2. *Directions.*
   a. Pass the end "A" (Fig. 264) around the object and the standing part of the rope.
   b. Tuck the end under its own part in such a way that the tension or pull on the standing part will hold the end "A" tight.

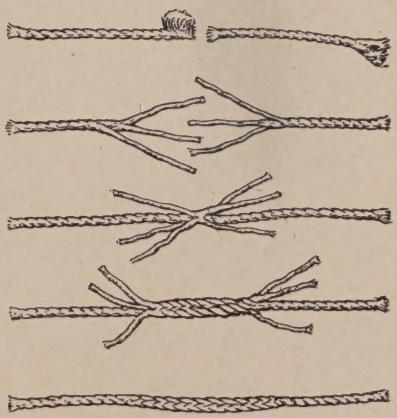


FIG. 263. ROPE SPLICING DONE BY PUPILS AT THE VOCATIONAL SCHOOL, LAMPETER, PA.

The Timber Hitch

1. *Purpose.* The timber hitch (Fig. 265) is used in handling logs and timber in the forests and on construction jobs.
2. *Directions.*
   a. Begin as in the half hitch by passing the end "A" around the object and the standing part of the rope.

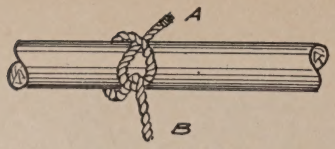


FIG. 264. THE HALF HITCH

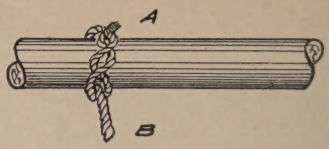


FIG. 265. THE TIMBER HITCH

b. Complete the hitch by wrapping the end "A" around itself several times.

The Blackwall Hitch

1. *Purpose.* A blackwall hitch is used where it is desired to hitch a rope temporarily to a hook on which a uniform pull is applied.

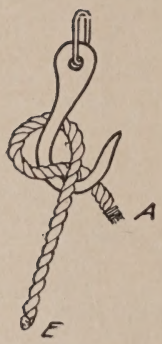


FIG 266. THE BLACKWALL HITCH

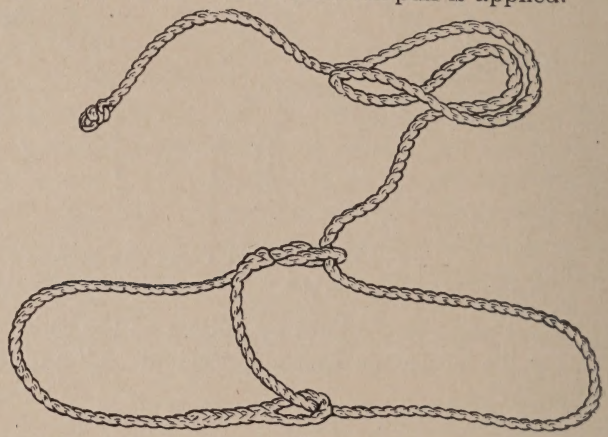


FIG. 267. ROPE HALTER MADE BY PUPILS AT THE VOCATIONAL SCHOOL, LAMPETER, PA.

2. *Directions.*
   a. Throw the end "A" (Fig. 266) around the standing part "B."
   b. Tuck the end "A" under itself so that the tension on the rope will hold the hitch in place.

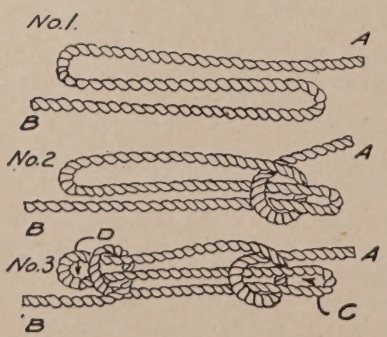


FIG. 268. THE SHEEPSHANK

The Sheepshank

1. *Purpose.* The sheepshank is used to shorten a cord or a rope either temporarily or permanently.
2. *Directions.*
   a. Form a double loop as shown in No. 1, Fig. 268, making the loops so that they will take up the necessary length of rope.
   b. With the left hand grasp the double loop near the right end and throw a half hitch over that end as shown in No. 2.

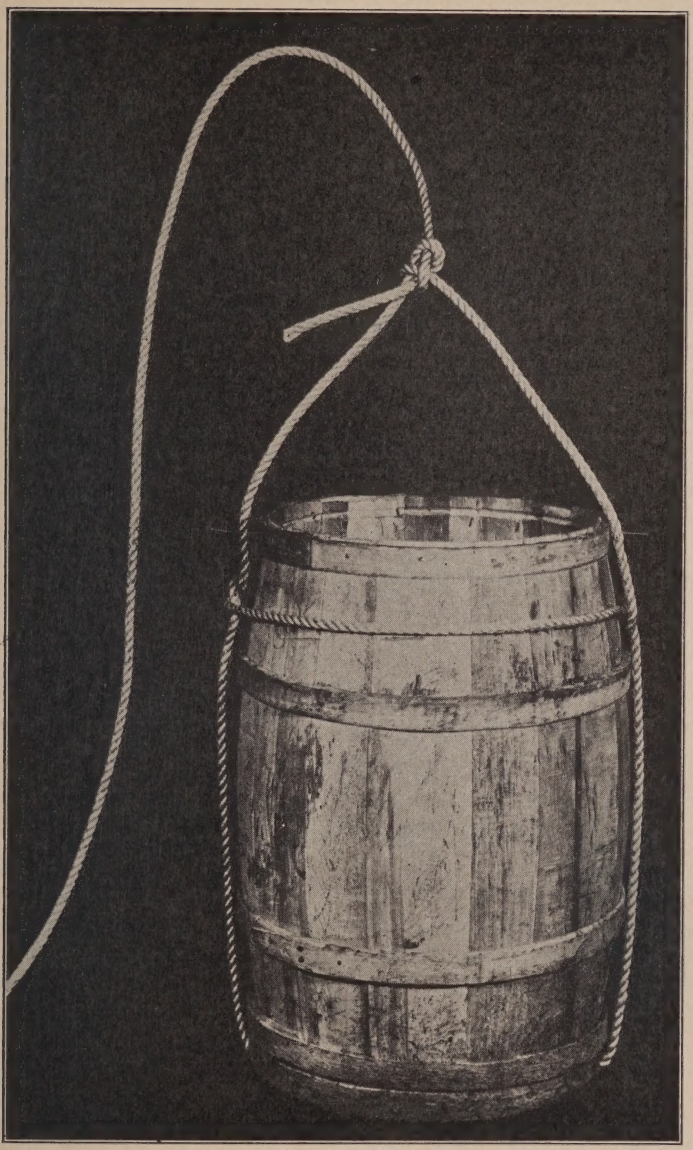


FIG. 269. THE BARREL HITCH

Photograph reproduced by permission of P. G. Holden, International Harvester Co., Chicago, Ill.

c. Grasp the opposite end in the same manner and throw a half hitch over this end also.

d. In order to make the sheepshank hold better under certain conditions pass the end "A" through the loop "C," and likewise pass the end "B" through the loop "D."

REFERENCES

1. *Free bulletins and circulars.*
Farm Craft Lessons. Davenport, Eugene. Issued by the U.S. Boys' Working Reserve, U.S. Employment Service, Department of Labor.
Knots, Hitches, and Splices. Riley, H. W. Cornell Reading Courses, vol. 8, Cornell University, Ithaca, N.Y.
Rope and Its Uses. Burger, A. A. Extension Bulletin No. 24, 1920, Agricultural Extension Department, Iowa State College, Ames, Iowa.
Use of Rope on the Farm, The. Overholt, Virgil. Bulletin No. 5, 1916–17, Agricultural Extension Department, Ohio State College, Columbus, Ohio.
2. *Text and reference books.*
Boy Scouts of America. *Handbook for Boys.* (Chapter I.) Published by the Boy Scouts of America, 200 Fifth Avenue, New York.
Hasluck, Paul N. *Knotting and Splicing Ropes and Cordage.* David McKay, publisher.
International Harvester Company Bulletins (vol. V, Lessons 20 to 56 inclusive). P. G. Holden, Director Agricultural Extension Service, International Harvester Co., Chicago, Ill.
Kent, Wm. *Mechanical Engineer's Handbook.* John Wiley & Sons.
Merriman, Mansfield. *American Civil Engineer's Handbook.* Ed. 4, 1920. Wiley and Sons.
Ramsower, Harry C. *Equipment for the Farm and the Farmstead.* (Chapter 28.) Ginn & Co.
Roehl, Louis M. *Rope Work.* The Bruce Publishing Co.
Roehl, Louis M. *Agricultural Woodworking.* The Bruce Publishing Co.
Verrill, Alpheus Hyath. *Knots, Splices, and Rope Work.* Norman W. Henley Co.

CHAPTER XIX

BELT AND HARNESS REPAIRING

Practical Information about Belting

LEATHER belting is made up of many short pieces of leather, each being perhaps four feet long in the rough. These are cemented together, end to end. The ends are scarfed or beveled, so as to produce a lap of from 4″ to 7″ in belts up to 8″ wide. In order that the belting may wear as long as possible, belts of single thickness should be placed so that the inside points of the laps run toward the pulleys as shown herewith.[1]

It is desirable to run the grain or hair side of single thickness belting on the pulleys as better friction, more strength, and maximum wear is secured in this way.

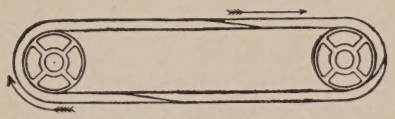


FIG. 270. THE RIGHT WAY TO RUN LEATHER BELTS

Mineral and vegetable oils injure belting, and result in loss of power by causing the belt to slip. Rosin should never be used to make a belt "stick" better. Its effect is only temporary. It combines with dust and dirt and collects in lumps that result in excessive wear on the belt. If a belt dressing is wanted that will serve in case of an emergency by increasing the friction between the belt and the pulleys, it should be one that causes no harmful effects.

Neat's-foot oil is a good belt dressing that increases the life of belting if it is properly applied. Most persons apply it too freely. A little should be applied on the side of the belt next to the pulleys, and more should be used on the opposite side. This enables it to soak through to the wearing surface gradually. Too much oil will weaken the fibers of the leather.

Good belt dressings are also made by reliable manufacturers. Follow directions closely when using any product of this kind.

Dampness is injurious to ordinary leather belting unless it is waterproofed. If laps should become loose, they should be cemented together again. Rivets are not so satisfactory.

Pulleys should be at least ½″ wider than the belt in order to allow for irregularity in the belt. Crowned pulleys are to be preferred where they can be used, but the crown should not be too high.

In lacing belts care should be used to obtain ends that are square, and the lacing should be put in with equal tension all the way across the belt.

[1] J. E. Rhoads & Sons, *Belt User's Book*.

How to Figure the Length of a Belt [1]

1. *When both pulleys are nearly the same size.* Multiply one half of the sum of the diameters of the two pulleys by 3.14. To this number add twice the distance between the centers of the shafts, giving the required length.
2. *When the two pulleys are of quite different diameters.* To obtain the desired length, add together the numbers resulting from a, b, and c.
   a. Multiply one half of the sum of the diameters of the two pulleys by 3.14.
   b. Multiply the distance between the centers of the shafts by 2.
   c. Square the difference in the diameters of the two pulleys, and divide by four times the center distance.
3. *For crossed belts.* To obtain the desired length, add together the results of a and b.
   a. Multiply one half of the sum of the diameters of the two pulleys by 3.14.
   b. Square one half the sum of the diameters of the two pulleys. Add to this result the square of the center distance. Extract the square root of the sum and multiply by 2.

Rules for Calculating the Speed of Pulleys [2]

Problem 1 — *The diameters of both pulleys and the revolutions of one being given, to find the number of revolutions of the other:* Multiply the diameter of the one by its number of revolutions and divide the product by the diameter of the other. The result will be the number of revolutions.

Problem 2 — *The diameter and revolutions of one pulley being given, to find the required diameter of the other to procure any given number of its revolutions:* Multiply the diameter of the one by the number of its revolutions and divide the product by the number of revolutions of the other; the result will be its diameter.

Problem 3 — *To ascertain the size of the driver:* Multiply the diameter of the driven pulley by the number of revolutions you wish to make and divide the product by the revolutions of the driver shaft; the result will be the size of the driver.

The above rules are practically correct, though owing to the slip, elasticity, and thickness of the belt, the circumference of the driven pulley seldom runs as fast as the driver.

Methods of Lacing Belts

1. *Metallic belt lacing (composition wire).* Information regarding the size of metallic lacing that is suited to various widths of belts is

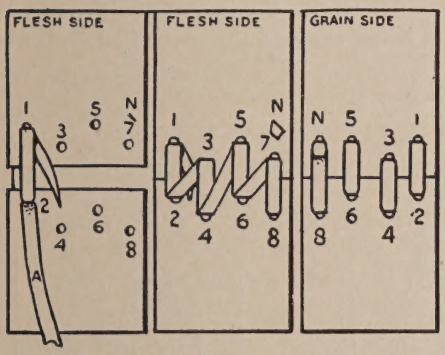
[1] Graton and Knight Manufacturing Co., Bulletin No. 101.
[2] From *Belt User's Book*, J. E. Rhoads & Sons, Philadelphia.

given in Chapter IV under "Belt Lacing." This type of lacing is used chiefly on narrow belts.

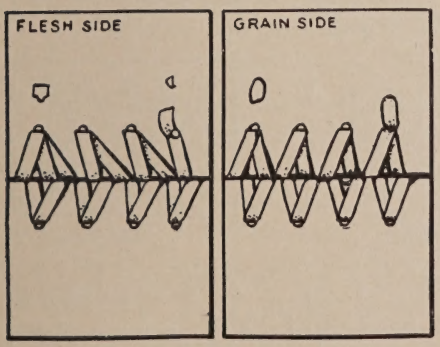
2. *Patent belt hooks and plate fasteners.* There are many kinds on the market. The steel belt lacing shown herewith is one of the effective fasteners of this type.

FIG. 271. STEEL BELT LACING
From Catalogue of the Chicago Belting Co.

3. *Leather and rawhide lacing.* Leather and rawhide lacing is widely used. The following general directions need to be observed:
   a. Use a square to make sure ends of belt are cut off squarely.
   b. Punch the holes as shown in the following illustrations so that they are exactly opposite each other.
   c. Use a belt punch for leather, and an awl for making holes in fabric belts.
   d. The spacing for the holes is shown in the accompanying table.
   e. See that the lacing is given uniform tension throughout.



No. 1



No. 2

FIG. 272. METHODS OF LACING BELTS

Lace with Flesh Side up [1]

Stye No. 1

Put lace down through 1, up through 2, down through 1, up through 2, down through 3, up through 4, down through 3, up through 4, down through 5, up through 6, down through 5, up through 6, down through 7, up through 8, down through 7, up through 8, down through 7. Punch hole with awl and fasten in the usual manner at N.

Style No. 2

Fastening one end of the lace in two slots above hole, pass the lace down through 1, up between the ends of the belt at 1^1, down through 2, up between the ends at 2^1, down through 1, up between

[1] From *Belt User's Book*, J. E. Rhoads & Sons, Philadelphia.

the ends at 1^2, down through 2, up between the ends at 2^2, down through 3, up between the ends at 3^1, down through 4, up between the ends at 4^1, down through 3, up between the ends at 3^2, down through 4, up between the ends at 4^2, down through 5, up between the ends at 5^1, down through 6, up between the ends at 6^1, down through 5, up between the ends at 5^2, down through 6, up between the ends at 6^2, down through 7, up between the ends at 7^1, down through 8, up between the ends at 8^1, down through 7, up between the ends at 7^2, down through 8, up between the ends at 8^2, down through 7. Punch hole with awl and bring the end up at N, and cut off.

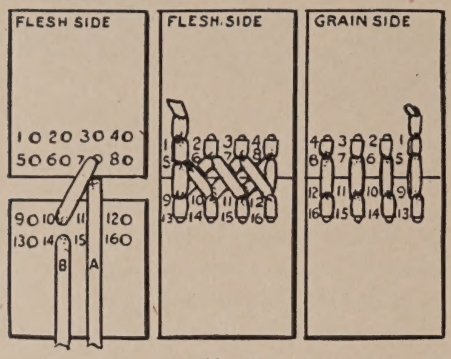


FIG. 272. METHODS OF LACING BELTS

Style No. 3

Have the end A three times as long as end B.

Put lace A down through 7, up through 11, down through 8, up through 12.

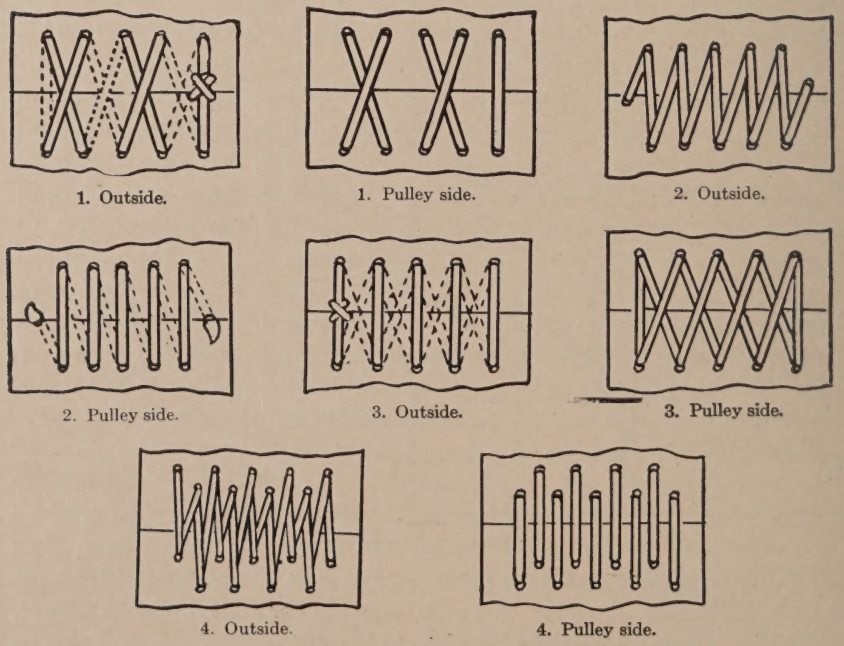


FIG. 273. FOUR METHODS OF LACING BELTING

(From Chicago Belting Co.'s. Catalogue.)

Put lace B down through 10, up through 6, down through 9, up through 5.

Put lace A down through 8, up through 4, down through 8, up through 12, down through 16, up through 12, down through 7, up through 3, down through 7, up through 11, down through 15, up through 11, down through 6, up through 2, down through 6, up through 10.

Put lace B down through 9, up through 13, down through 9, up through 5, down through 1.

Put lace A down through 14, up through 10, down through 5, up through 1. Punch hole with awl and fasten in the usual manner at N.

TABLE SHOWING WIDTHS OF LACE, NUMBER OF HOLES, ETC., FOR VARIOUS WIDTHS OF BELTING, EITHER SINGLE OR DOUBLE

WIDTH OF BELT INCHES	WIDTH OF LACE INCHES	NUMBER OF HOLES	DISTANCE OF HOLES FROM END	
			First Row Inches	Second Row Inches
1 to 1¾	¼	2 or 3	⅜	*None needed*
2 to 2½	5/16	3	⅜	⅞
2¾ to 3½	5/16	4	½	1
3½ to 5	⅜	5	⅝	1⅛
6	7/16	6	¾	1¼
7	7/16	7	¾	1¼
8	½	8	⅞	1⅜
10	½	10	1	1¾
12	½	12	1	1¾
14 and above	⅝	13	1	1¾

Don't punch holes too near the end.

Don't punch holes too close together.

Don't use too large a punch; if anything is to break, let it be the laces. Have the lacing fold within the holes rather than to make a large lace hole. Diameter of hole should be less than width of lace used.

HARNESS REPAIRING

Tools

IT will be seen from the description given in Chapter II, under "Tools used in harness and leather repair work," that very few tools are absolutely required for repair work in leather. For example, stitching can be done with harness thread, needle, and an awl. If a knife needs to be used, a sharp pocket knife, or a kitchen knife, may serve the purpose.

There are several inexpensive tools that are convenient and that facilitate good work. A pricking wheel may be used to lay off the spaces for the stitches. If only a minimum number of tools are to be purchased, it is better to buy a finishing wheel instead of a pricking wheel. The finishing wheel can be used to lay off the stitches, and after they are made, the tool is run over them so as to make them appear as uniform as possible.

Similarly a common edging tool is of service in giving additional finish

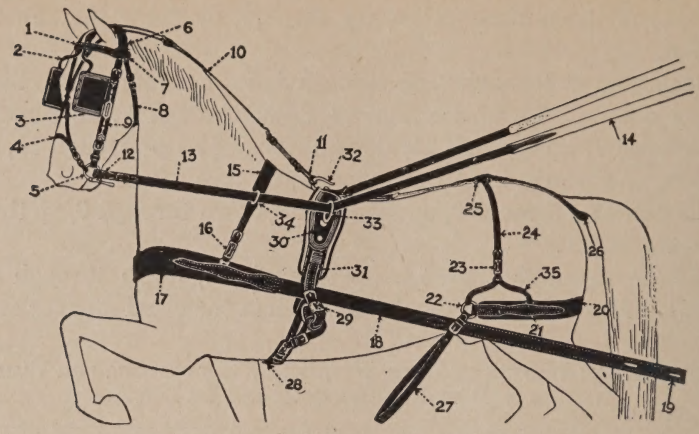


FIG. 274. SINGLE BUGGY HARNESS PARTS

1. Bridle fronts. 2. Winker brace. 3. Blinds. 4. Noseband in overcheck. 5. Bit. 6. Crown piece. 7. Rosette. 8. Throat latch. 9. Bridle cheek (box loop). 10. Overcheck. 11. Overcheck end loop. 12. Spring billet on line. 13. Line (front part). 14. Hand part on line. 15. Neck strap. 16. Breast collar lead up. 17. Breast collar body. 18. Trace. 19. Heel of trace (showing dart hole). 20. Breeching body. 21. Breeching layer. 22. Breeching ring. 23. Breeching tugs, 3-ring stay. 24. Hip strap. 25. Turnback. 26. Crupper. 27. Breeching strap. 28. Bellyband. 29. Shaft tug. 30. Gig saddle. 31 Gig saddle bearer. 32. Bolt hook. 33. Terret. 34. Neck strap terret.

to the job, and a creasing tool may be used to enhance the appearance of the repair work.

It is desirable to have one or more types of leather punches. A four tube revolving belt punch is very useful. If riveting is to be done a rivet set or else a simple riveting machine is helpful.

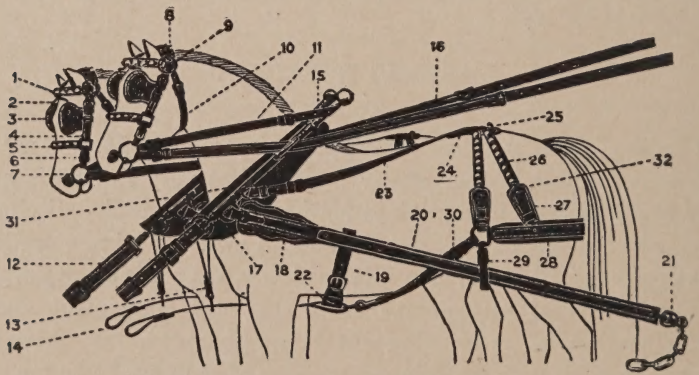


FIG. 275. TEAM HARNESS PARTS

1. Bridle front. 2. Winker brace. 3. Blind. 4. Bridle cheek. 5. Noseband. 6. Bit strap. 7. Bit. 8. Crown piece. 9. Rosette. 10. Throat latch. 11. Side rein. 12. Breast strap. 13. Collar strap. 14. Choke strap. 15. Hame. 16. Line. 17. Collar. 18. Trace safe. 19. Bellyband billet. 20. Trace. 21. Chain. 22. Bellyband. 23. Turnback. 24. Safe under hip. 25. Trace carrier. 26. Hip strap. 27. Lead ups on breeching. 28. Breeching body. 29. Lazy strap. 30. Side strap. 31. Back strap ring on hame. 32. Safe on lead ups.

Materials

A brief description of materials used in leather repair work is found in Chapter IV under the caption of "Materials used in harness and leather repair work." A more detailed description of those materials that are essential to harness repair work is herewith given.

Leather. The term "leather" is given to the skins of animals such as cattle after the skins have undergone several processes. After the hide is

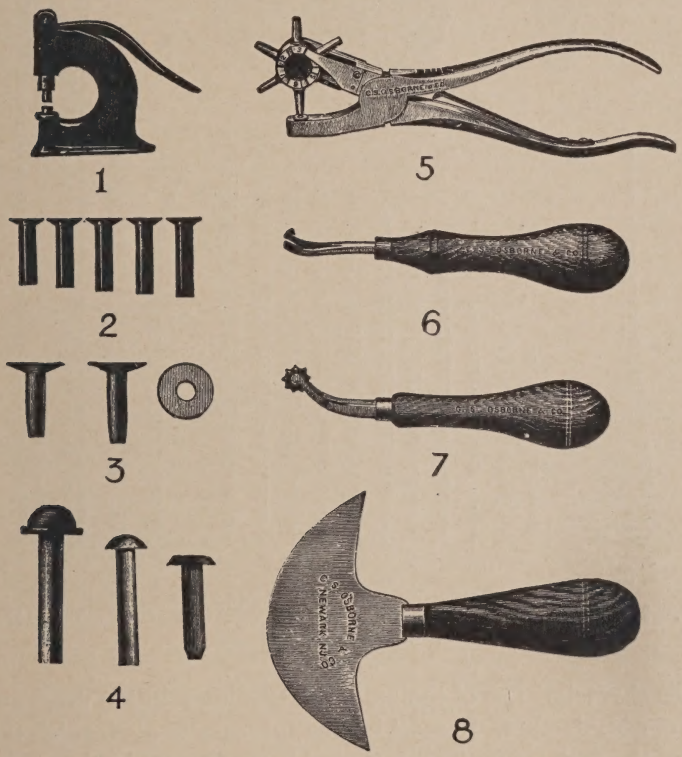


FIG. 276. 1. HAND RIVETER. 2. TUBULAR RIVETS. 3. COPPER RIVETS. 4. HAME RIVETS. 5. REVOLVING PUNCH. 6. EDGER. 7. FINISHING WHEEL. 8. KNIFE.

taken from the animal it is usually heavily salted on the flesh side so as to preserve it until it may be tanned. Tanning involves several processes. The first of these removes the hair from the hides and prepares them for the second step which is the actual process of tanning. Hides are tanned by means of tannic acid that is found in hemlock bark, in oak bark, and in other substances. Oak tanned leather, other things being equal, is usually preferred. After the hides are tanned they go through the last process known as the finishing process. This consists in a number of operations that produce the proper color, flexibility, and thickness of the leather. The quality of leather depends upon the

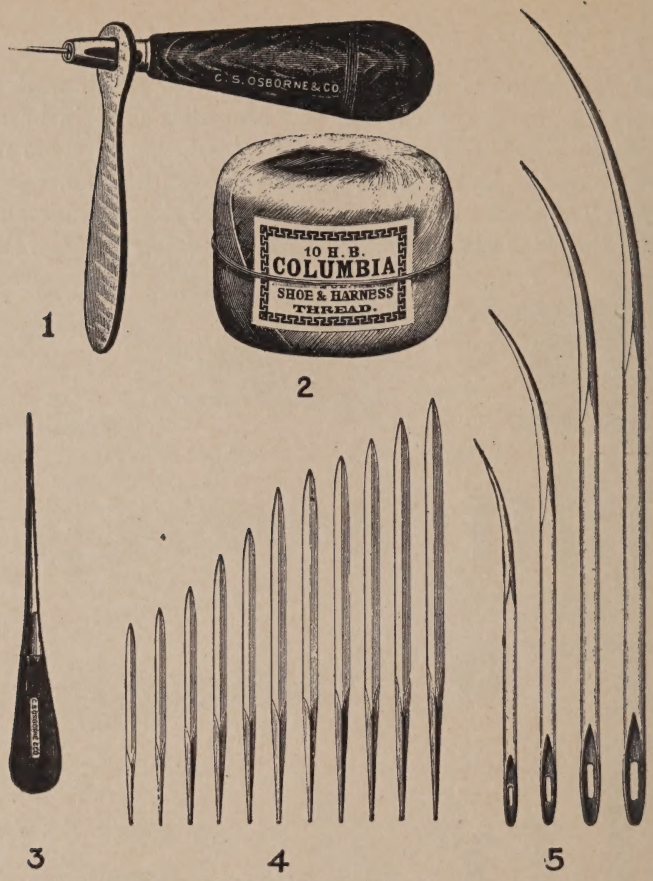


FIG. 277. 1. PATENT AWL. 2. FLAX THREAD. 3. AWL. 4. REGULAR HARNESS AWLS. 5. COLLAR NEEDLES.

nature or characteristics of the hide, the tanning solution used, and the process of manufacture. In most leather it is easy to distinguish the hair side from the flesh side. This is desirable, as harness leather is usually faced with the hair side outward.

Thread. Good, strong thread is needed to make repairs that will "stand up" under hard usage. Flax thread has been found to be most useful for the purpose because of its high tensile strength and excellent wearing qualities.

Wax. Ordinary shoemaker's or harness-maker's wax is used in forming the flax strands into thread. This wax holds the strands together to some extent, and thereby increases the strength of the thread.

Another kind of wax, common beeswax, is also used whenever thread needs to be made "slicker" so that it will pull through the holes easier.

Harness oil. Neat's-foot oil is recommended. If it is to be darkened this may be done by stirring common powdered lamp-black into the oil until the latter has a glossy appearance.

Harness repair parts. Harness repairing is greatly simplified by various repair parts, such as buckles, snaps, loops, links, etc., that are usually carried in local stores, or that are purchased from mail order houses. It is desirable to have a limited supply of essential repair parts on hand at all times. See Fig. 280.

Making a Harness Thread

Four processes are involved in making a harness thread. These are as follows:

1. Measuring the thread.
2. Tearing the thread.
3. Assembling the threads into a harness thread.
4. Waxing the harness thread.

Measuring. A Number 10 flax thread is satisfactory for harness stitching. In order to obtain a thread of sufficient length cut the thread six inches longer than what is required for the stitching to be done. Lengths up to five feet long may be handled advantageously.

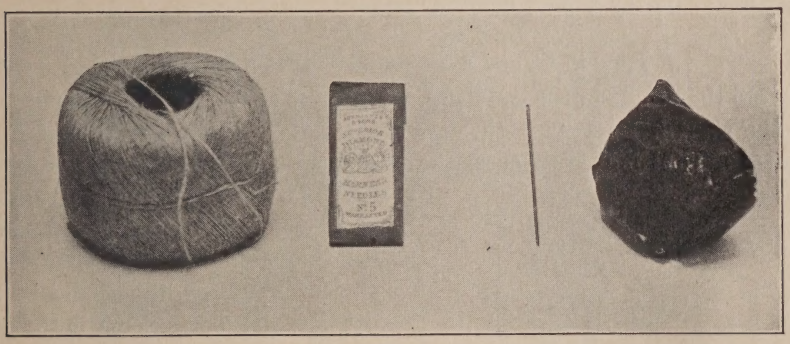


FIG. 278. MATERIALS USED TO MAKE A HARNESS THREAD

Ball of No. 10 linen thread; needles; shoemaker's wax. (Figs. 278, 281–284 from *Harness Repairing*, F. G. Behrends. Cornell Reading Course for the Farm, Lesson 160.)

Tearing the strands. Threads should not be cut to length, nor should they be broken without first untwisting the threads, as this would result in a blunt end that would not pass through the eye of the needle. In order to untwist a thread hold the thread between the thumb and first finger of the left hand with the latter six inches away from, and to the left of, the right thigh. With the palm of the right hand roll the thread downward over the right thigh until the fibers are separated. Then break them with a quick jerk. This will give a torn thread with a long, tapering point.

Assembling the threads. The assembled harness thread is made up of a number of separate flax threads. For stitching light leather three threads may be used to form the harness thread; for heavy stitching as on traces and hame tugs six or seven flax threads may be assembled to

form a harness thread of sufficient strength. Stagger the ends of the threads, that is, let each thread extend an inch or so beyond the next, so that the end of the completed harness thread will be in the form of a slender taper that can readily be drawn through the eye of a needle.

Waxing the thread. The final process of making a harness thread consists in waxing the thread. This is done in the following manner. Wind one end of the thread around the end of the first finger of the left hand, and the other end around the second finger of the same hand. Throw the middle of the thread over a nail or hook so that the thread can be pulled taut. Take the wax in the right hand and apply it to the thread by rubbing it briskly over a short part of the thread at a time. This generates heat and causes the wax to adhere to the thread. When the entire thread has been waxed, continue to rub the wax into the thread by passing it between the thumb and first finger. In order to make the waxed thread pull as easily as possible, apply beeswax over the harness-maker's wax but be careful not to put beeswax on the end near the needle, as this would cause the thread to pull out of the eye too easily because of lack of sticking quality on the thread near the needle.

How to thread a Harness-Maker's Needle

Hold the needle in the left hand. With one tapered end of the thread in the right hand pass it through the needle. When the thread has passed several inches through the eye of the needle double the thread back upon itself by using the thumb and first finger of the left hand. With the thumb and first finger of the right hand roll the needle in a clockwise direction, and at the same time draw it forward so as to cause the end of the thread to form a neat spiral around the main thread, thus holding the needle in place.

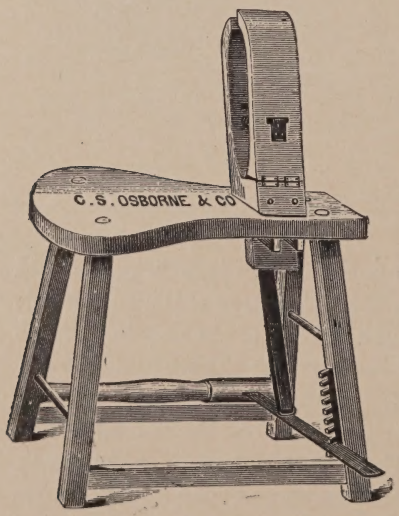


Fig. 279. Stitching Horse

Stitching

If a strap is to be spliced by stitching, first cut the two ends off square. Next bevel the two ends with a knife. The bevels should be from the flesh side to the hair side, and should be several inches in length. Place the two ends so that the hair side of both pieces will be on the same side when they are stitched. In order to facilitate good work use two small tacks to hold the ends temporarily in position. Take a rule and a pointed tool such as the leg of a pair of dividers, and mark off the spac-

ings for the stitches, or if a pricking or finishing wheel is at hand use this on the hair side of the strap. Next place the ends in a stitching clamp or a vise.

The following method is frequently used in stitching: pass the awl through the leather at a point just beyond the lap; place the left needle in this hole and place the right needle in the hole above the left needle; pull both needles through, and tighten up on the threads; continue the

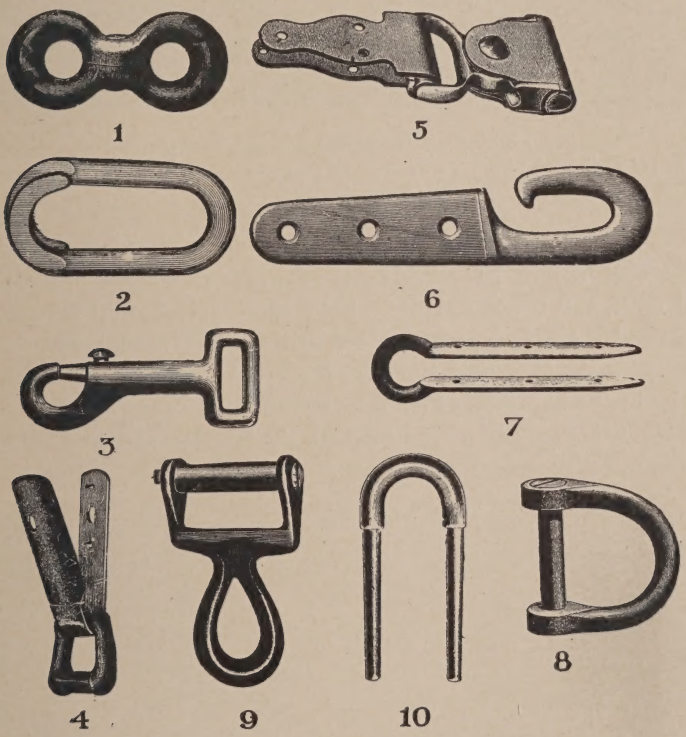


FIG. 280. MISCELLANEOUS REPAIR PARTS

1. Lap repair link. 2. Open repair link. 3. Snap. 4. Repair hame bottom loop and clip. 5. Concord clip. 6. Tug hook. 7. Hame clip. 8. Screw dee. 9. Screw cockeye. 10. Hame staple.

process without laying down either needles or the awl between stitches until a point just beyond the end of the lap is reached; reverse the strap in the clamp and proceed as before. The threads may be crossed on the flesh side of the leather. When the stitching is completed, the thread can be fastened by turning back one stitch. Cut the ends of the threads off flush with the surface of the leather.

In order to give the work a more finished appearance, run a finishing wheel over the stitching. Next lay the hair side of the splice on a smooth surface and pound down the stitches on the flesh side with a hammer.

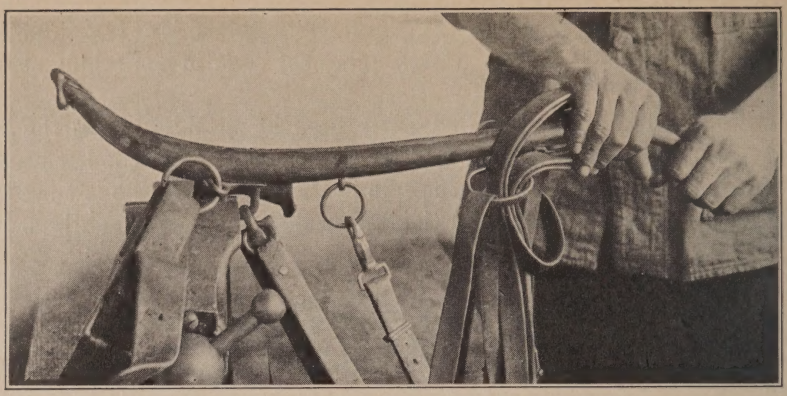


FIG. 281. REMOVING A HAME STAPLE

One half of the staple is placed in the corner of a vise. Moving the hame back and forth will break the staple.

Riveting

A broken strap may be spliced by the use of several types of rivets, such as solid, split, and tubular rivets. Solid copper rivets and burrs are frequently used. A hole is punched or drilled through the leather, a rivet of proper size is inserted, and the burr is riveted fast with a riveting hammer, a ball pene hammer, or similar tool.

Split rivets are simply driven through the lapped ends, and the ends of the rivets are clinched.

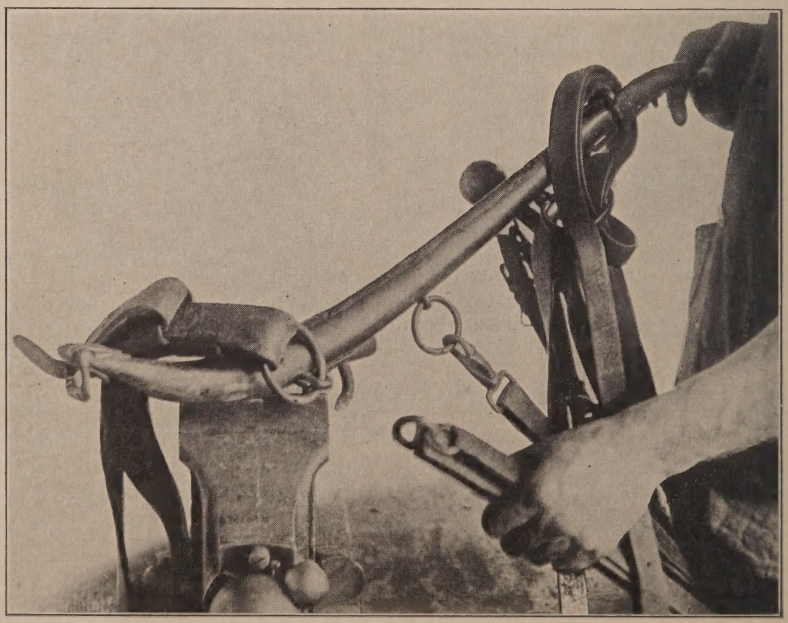


FIG. 282. REMOVING A HAME STAPLE

The staple is broken and the tug removed.

A comparatively inexpensive machine is required if tubular rivets are to be used.

Replacing a Hame Staple

Occasionally the hame staple (Fig. 280, Miscellaneous Repair Parts, No. 10) needs to be replaced. The method of doing this is illustrated in the figures shown herewith which are reproduced by permission from Mr. F. G. Behrends's excellent bulletin: *Harness Repairing*, Lesson 160, Cornell Reading Course for the Farm.

The following processes are involved:

1. Break the worn staple by placing one leg of the staple in a metal vise, and move the hame backward and forward until the staple is broken. In case a metal vise is not at hand, the staple may be broken with a cold chisel, a hack saw, or with a file.
2. Break or cut the exposed part of the staple off close to the hame.
3. If the hame staple is tapered (as shown in Fig. 280, Miscellaneous Repair Parts, No. 10) drive the staple in far enough so that the burrs or washers may be cut away from the ends of the staple. Then remove the staple with a punch.
4. If the hame staple has points or legs that do not taper the staple can be punched out without removing the burrs or washers.
5. Insert the new rivet through the hold-back plate and hame, cut the extra length from the staple, place the burrs or washers in position, and rivet as shown in the accompanying illustration.

Harness Clamp

1. *Purpose.* The harness stitching clamp illustrated in the accompanying drawing (Fig. 285) is intended for use in a steel bench

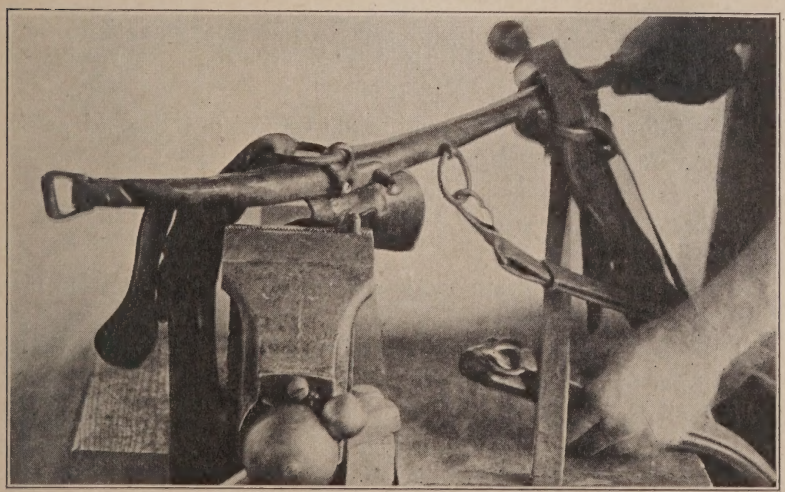


FIG. 283. REMOVING A HAME STAPLE

Moving the hame up and down breaks the half of the staple off. Half of the staple is seen, broken close to the hame and below the shoulder.

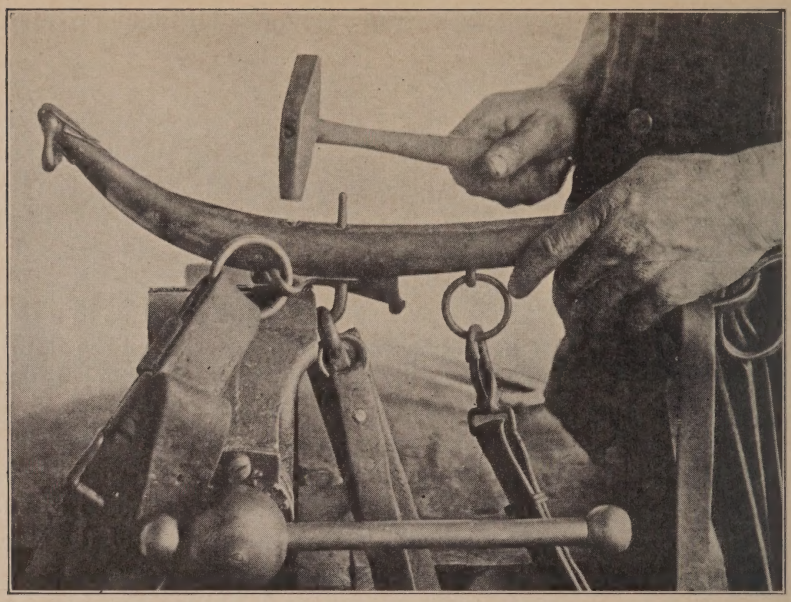


FIG. 284. RIVETING ON THE NEW HAME STAPLE
Showing extra length cut off and washer placed on before riveting.

vise such as those used by farmers, machinists, and blacksmiths. It may also be used in a woodworker's vise. Straps, tugs, and other articles may be held conveniently in such a clamp when stitching is to be done.

2. *Material required.*

a. *Lumber.* Oak, or other hard wood.

NO. OF PIECES	DIMENSIONS	PURPOSE
2	$13/16'' \times 3\frac{3}{4}'' \times 15''$	Sides
1	$13/16'' \times 13/16'' \times 3\frac{3}{4}''$	Spacer

b. *Hardware.*

1 doz. ¾″ No. 8 flat-head bright screws, or 2 doz. 3d. common wire nails.

½ doz. 6d. finishing nails.

c. *Leather.* 1 piece $2\frac{7}{16}'' \times 3\frac{3}{4}''$.

3. *Directions.*

a. Use a saw to obtain the bevels on the ends of the side pieces. Finish with a plane.

b. Make the part "B" so that the top face is ⅛″ narrower than the lower face, as shown in the detail drawing.

c. Nail or screw the part "B" to the part "A" placing the nails or screws so that they will not show from the outside of the clamp.

d. Hinge the part "C" to the part "B" by means of a leather hinge as shown.

e. In order to use the clamp simply set it into any available vise,

and apply sufficient pressure to hold the material to be stitched firmly in place.

Suggestions on Care of Harness

In order to make a harness last as long as possible, it is advisable to observe the following precautions:

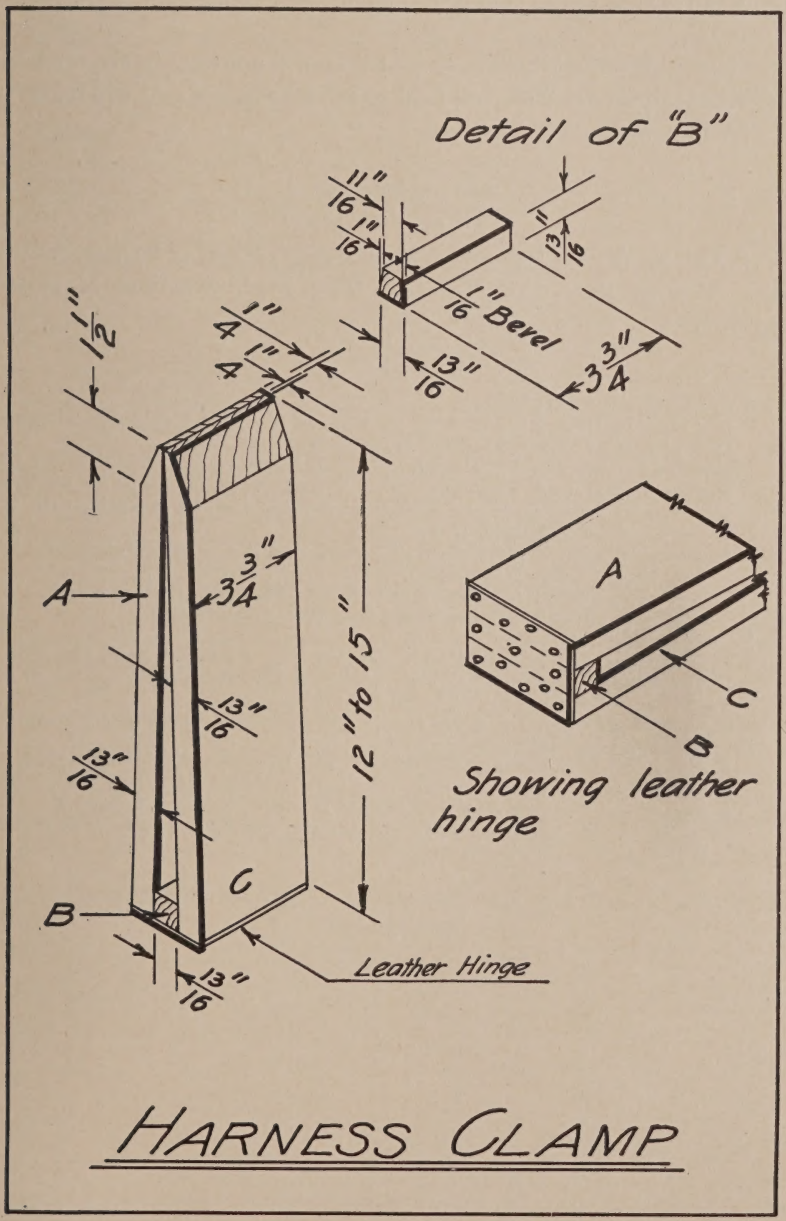


FIG. 285. HARNESS CLAMP

1. Clean the harness whenever it gets dirty.
2. Use water to wash off dirt or mud, but do not let the leather soak in water.
3. Never use hot water on leather.
4. After washing, dry the leather slowly in the shade — not in the sun or near a stove.
5. Keep it well oiled. Oil a harness at least twice a month when it is in use.
6. If possible adjust buckles so that they will not wear in the same hole all of the time. This will help to retard rotting, and will make the parts wear longer.

Acknowledgments

(Not noted elsewhere)

C. S. Osborn & Co., Newark, N.J., for illustrations of harness-maker's tools. Strecker Bros. Co., Marietta, Ohio, for illustrations of harness hardware.

REFERENCES

1. *Free bulletins and circulars.*
Belt User's Book. Rhoads, J. E., & Sons, 12 N. Third Street, Philadelphia.
Care of Leather, The. Farmers' Bulletin No. 1183.
Chicago Belting Co. Catalogue. 113–125 North Green Street, Chicago, Ill.
Harness Repairing. Behrends, F. G. Cornell Reading Course for the Farm. Lesson 160, August, 1921. Extension Service, College of Agriculture, Cornell University, Ithaca, N.Y.
Manual for Farriers, Horseshoers, Saddlers, and Wagoners or Teamsters. U.S. War Department, Washington, D.C. Document No. 486, 1914.
Standardized Leather Belting. Bulletin No. 101. *How to Stick a Belt.* The Graton & Knight Manufacturing Co., Worcester, Mass.
2. *Text or reference books.*
Brace and Mayne. *Farm Shop Work,* chap. LI. American Book Co., 1915.
Paul Hasluck. *Harness Making.* Cassell & Co., New York.
Paul Hasluck. *Saddlery.* Cassell & Co., New York.
J. C. Jordan. *Art of Making Harness Successfully.* Tuskegee Normal and Industrial Institute, Tuskegee, Ala.
Roehl, Louis M. *Harness Repairing.* The Bruce Publishing Co., 1921.
Harness-Maker's Complete Guide. National Harness Review, Chicago, Ill.
Harness Shop Estimate Book. National Harness Review, Chicago, Ill.
Illustrated Guide for Harness-Makers, Cutters, and Apprentices. The Harness World, Cincinnati, Ohio.

APPENDIX

A. DATA CONCERNING STRENGTH OF MATERIALS

Bearing Power of Soil

The safe pressure that can be imposed on any given soil is largely a matter of judgment and experience. The following figures are typical of good practice:

Kind of Soil	Bearing Power in Tons per Sq. Ft.
Soft clay	1
Ordinary clay and sand in layers, wet and springy	2
Loam, clay or fine sand, firm and dry	3
Very firm coarse sand, stiff gravel or hard clay	4

Bearing Power of Long-Leaf Yellow Pine and White Oak Posts

(Safe load in tons)

Length (in feet)	Width and Thickness (in inches)		
	4×4	6×6	8×8
8	4	6	8
10	3	5	7
12	2	4	6
14	1	3	5
16		2	4
18		1	3

Bearing Power of Gas-Pipe Posts

(Safe load in tons)

Length (in feet)	Diameter of Pipe (in inches)				
	2″	3″	4″	5″	6″
8	4	8	12	16	20
9	3	7	10	14	18
10	2	6	8	12	16
12	1	5	6	10	14
14		4	5	8	12

Safe Load in Tons for Long-Leaf Yellow Pine and White Oak Beams and Girders

Length (in feet)	Width and Thickness (in inches)				
	2×6	3×6	4×6	6×6	8×8
6	1	1½	2	3	5½
8	¾	1	1½	2½	5
10		¾	1¼	2	4½
12		½	1	1½	3
14			½	1	2½
16				½	2
18					1

Strength of Cement

The tensile strength of Portland cement should be:

175 lbs. per sq. in. for neat cement 24 hours old
500 lbs. per sq. in. for neat cement 7 days old
600 lbs. per sq. in. for neat cement 28 days old

The compressive strength of cement when it is thoroughly hardened should equal at least 3000 lbs. per square inch for a 1: 2½: 5 mixture, and 2000 lbs. per square inch for a 1: 3: 5 mixture.

Strength of Steel

The ultimate tensile strength, or the breaking strength of structural steel is from 55,000 to 65,000 lbs. per square inch. The safe working stress is frequently taken to be 16,000 lbs. per square inch. The safe working stresses are taken to be about ¼ the breaking stress.

Strength of Manila Rope

The strength of three-strand manila rope is shown in Table 18. American two-strand hemp rope is rated by the United States Navy Department as being 85 per cent as strong as the three-strand rope.

REFERENCES

Kent, Wm. *Mechanical Engineers' Handbook.* John Wiley & Sons.
Kidder, Frank E. *Architects' and Builders' Pocketbook.* John Wiley & Sons.
Merriman, Mansfield. *American Civil Engineers' Handbook.* John Wiley & Sons.

B. ADDRESSES OF PUBLISHERS REFERRED TO IN THE SELECTED REFERENCES GIVEN AT THE ENDS OF CHAPTERS

American Book Company, 100 Washington Square, New York City.
Atkinson, Mentzer & Company, 3 West 36th Street, New York City.
Bruce Publishing Company, 2020 Montgomery Building, Milwaukee, Wis.
David McKay, 604–608 South Washington Square, Philadelphia, Pa.
David Williams Company, 243 West 39th Street, New York City.
Ginn & Company, 70 Fifth Avenue, New York City.
Goodspeed Press, 5A Park Street, Boston, Mass.
Henley, Norman W., Company, 132 Nassau Street, New York City.
Lippincott, J. B., Company, East Washington Square, Philadelphia, Pa.
Macmillan Company, 66 Fifth Avenue, New York City.
Manual Arts Press, 105 Fourth Avenue, Peoria, Ill.
McGraw-Hill Publishing Co., 370 Seventh Avenue, New York City.
Orange Judd Company, 315 Fourth Avenue, New York City.
Prang Educational Company, 30 Irving Place, New York City.
Scott, Foresman & Company, 8 East 34th Street, New York City.
Taylor Holden Co., Springfield, Mass.
Van Nostrand, D. Co., 8 Warren Street, New York City.
Wiley & Sons, John, 432 Fourth Avenue, New York City.
Webb Publishing Company, 55–79 East Tenth Street, St. Paul. Minn.

ADDRESSES OF AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS

Alabama.	Alabama Polytechnic Institute and Agricultural Experiment Station, Auburn.
Arizona.	College of Agriculture and the Agricultural Experiment Station of the University of Arizona, Tucson.
Arkansas.	College of Agriculture and Agricultural Experiment Station of the University of Arkansas, Fayetteville.
California.	College of Agriculture and the Agricultural Experiment Station of the University of California, Berkeley.
Colorado.	The State Agricultural College of Colorado and the Agricultural Experiment Station, Fort Collins.
Connecticut.	Connecticut Agricultural College and the Storrs Agricultural Experiment Station, Storrs. Connecticut State Agricultural Experiment Station, New Haven.
Delaware.	Delaware College and the Agricultural Experiment Station, Newark.
Florida.	College of Agriculture and the Agricultural Experiment Station of the University of Florida, Gainesville.
Georgia.	Georgia State College of Agriculture, University of Georgia, Athens. Georgia Experiment Station, Experiment.
Idaho.	College of Agriculture and the Agricultural Experiment Station of the University of Idaho, Moscow.
Illinois.	College of Agriculture and the Agricultural Experiment Station of the University of Illinois, Urbana.
Indiana.	Purdue University (The School of Agriculture and the Agricultural Experiment Station), LaFayette.
Iowa.	Iowa State College of Agriculture and Mechanic Arts and the Agricultural Experiment Station, Ames.
Kansas.	Kansas State Agricultural College and the Agricultural Experiment Station, Manhattan.
Kentucky.	College of Agriculture and the Agricultural Experiment Station of the University of Kentucky, Lexington.

Louisiana.	Louisiana State University and Agricultural and Mechanical College and the State Experiment Station, University Station, Baton Rouge.
Maine.	College of Agriculture and Agricultural Experiment Station of the University of Maine, Orono.
Maryland.	Maryland State College of Agriculture and the Agricultural Experiment Station, College Park.
Massachusetts.	Massachusetts Agricultural College and Agricultural Experiment Station, Amherst.
Michigan.	The Michigan Agricultural College and the Agricultural Experiment Station, East Lansing.
Minnesota.	Department of Agriculture (School of Agriculture and Agricultural Experiment Station) of the University of Minnesota, University Farm, St. Paul.
Mississippi.	Mississippi Agricultural and Mechanical College and Agricultural Experiment Station, Agricultural College.
Missouri.	College of Agriculture and the Agricultural Experiment Station of the University of Missouri, Columbia.
Montana.	Montana State College of Agriculture and Mechanic Arts and the Agricultural Experiment Station, Bozeman.
Nebraska.	College of Agriculture and the Agricultural Experiment Station of the University of Nebraska, Lincoln.
Nevada.	College of Agriculture and the Agricultural Experiment Station of the University of Nevada, Reno.
New Hampshire.	New Hampshire College of Agriculture and the Mechanic Arts and the Agricultural Experiment Station, Durham.
New Jersey.	State College of Agriculture and the Mechanic Arts and Agricultural Experiment Station of Rutgers College and the State University of New Jersey, New Brunswick.
New Mexico.	New Mexico College of Agriculture and Mechanic Arts and the Agricultural Experiment Station, New Mexico.
New York.	New York State College of Agriculture and the Agricultural Experiment Station of Cornell University, Ithaca, New York State Agricultural Experiment Station, Geneva.
North Carolina.	North Carolina State College of Agriculture and Engineering, West Raleigh, and the Agricultural Experiment Station, Raleigh, and West Raleigh.
North Dakota.	North Dakota Agricultural College and the Agricultural Experiment Station. Agricultural College.
Ohio.	The College of Agriculture and of Veterinary Medicine, Ohio State University, Columbus. Ohio Agricultural Experiment Station, Wooster.
Oklahoma.	Oklahoma Agricultural and Mechanical College and the Agricultural Experiment Station, Stillwater.
Oregon.	Oregon Agricultural College and the Agricultural Experiment Station, Corvallis.
Pennsylvania.	The School of Agriculture and Agricultural Experiment Station, State College.
Rhode Island.	Rhode Island State College and the Agricultural Experiment Station, Kingston.
South Carolina.	Clemson Agricultural College and the Agricultural Experiment Station, Clemson College.
South Dakota.	South Dakota State College of Agriculture and Mechanic Arts and the Agricultural Experiment Station, Brookings.
Tennessee.	College of Agriculture and the Agricultural Experiment Station of the University of Tennessee, Knoxville.
Texas.	Agricultural and Mechanical College of Texas and the Agricultural Experiment Station, College Station.
Utah.	Agricultural College of Utah and the Agricultural Experiment Station, Logan.

Vermont.	College of Agriculture and Agricultural Experiment Station of the University of Vermont and the State Agricultural College, Burlington.
Virginia.	Virginia Agricultural and Mechanical College and Polytechnic Institute and the Agricultural Experiment Station, Blacksburg.
Washington.	State College of Washington and the Agricultural Experiment Station, Pullman.
West Virginia.	College of Agriculture and the Agricultural Experiment Station of West Virginia University, Morgantown.
Wisconsin.	College of Agriculture and the Agricultural Experiment Station of the University of Wisconsin, Madison.
Wyoming.	College of Agriculture and the Experiment Station of the University of Wyoming, Laramie.

INDEX

(References are to pages)

Accessories for concrete work, 268–72; working drawing, 269, 270.
Acid stains, use of, 54.
Aggregate, definition of, 41.
Agricultural colleges and experiment stations, addresses of, 371–73.
Angle for chisels, 28; for twist drills, 28.
Angle plate, illustration, 62.
Anvil, blacksmith's, illustration, 22.
Apple boxes, jig for making, 172, 173; working drawing, 173.
Arbor, grape, 176–80; working drawing, 176, 178; illustration, 177, 179.
"A"-shaped hog house, 191–93; working drawing, 192; illustration, 193.
Attitude, toward problems, 8.
Auger bits, how to sharpen, 27; set of, illustration, 15; types of, illustration, 15.
Awl, belt and sewing, illustration, 24.

Babbitt metal, description of, 49.
Ball pene hammer, illustration, 22.
Beams and girders, strength of, 369.
Belt and harness repairing, 353–68.
Belt, dressing, 50; lacing, 50; fasteners, 50; how to figure lengths of, 354; methods of lacing, 354–57; illustration, 355, 356.
Bench, green-house, 81–84; working drawing, 82; potting, 77–78; illustration, 77; working drawing, 78; washing, 292; working drawing, 291; work, 316–23; working drawing, 317, 319, 322, 323; illustration, 318, 320.
Berry carriers, 161–63; working drawing, 162.
Bibliography, relating to — belt and harness repairing, 368; cattle husbandry, 211; dairy husbandry, 252; equipment, self-made, 331; farm home, 295; field crops, 158; general farm projects, 285; horticulture, 179, 180; horse husbandry, 235; materials, 63; poultry husbandry, 144; rope, 352; sharpening tools, 38; sheep husbandry, 227; sketching and mechanical drawing, 341; strength of materials, 370; swine husbandry, 203; tools, 26; vegetable gardening, 92.
Bight, description of, 345.
Bits and drills, description of, 13; illustration, 15.
Bit, screwdriver, illustration, 15.
Blacksmithing, 1; place in curriculum, 2; nature of, 2; school shop equipment for, 10; tools used, 22; illustration, 22.
Blackwall hitch, 350; illustration, 350.
Block plane, 17; illustration, 16.
Blow torch, illustration, 24.
Board measure, table for figuring, 40.
Bolts, carriage, machine, and stove, 59, 60; illustration, 57; expansion, 60.
Book rack, 286, 287; illustration, 286; working drawing, 287.
Boring, tools used for, 12, 13; illustration, 15.
Bowline knot, 347, 348; illustration, 347.
Box, forcing, 75, 76; working drawing, 76; for tools and nails, 309, 310; illustration, 310; working drawing, 310; measuring, 268; working drawing, 269; miter, 302–04; working drawing, 303; mixing, 268; working drawing, 269; utility, 304, 305; illustration, 304; working drawing, 305.
Brace, corner, illustration, 62; ratchet, 12; description of, 12; illustration, 15.
Brads, illustration, 57; length, thickness, and weight, 58.
Breast drill, illustration, 22.
Briggs Standard taper pipe threads, 44.
Brooder coop, one-hen, 114–16; working drawing, 115; run-way for Fig. "A," 116; working drawing, 117; two-hen, 116–20; working drawing, 119.
Brush, cementer's, illustration, 20.
Bucksaw, illustration, 18.
Butcher's saw, illustration, 18.
Butt hinge, illustration, 62.
Butter paddle, 237; working drawing, 236.
Butter worker, lever, 249–52; working drawing, 250.

Cabinet-maker's glue, characteristics of, 56.
Calf stanchion, 243, 244; working drawing, 243; illustration, 241.
Cap, illustration, 43.
Carborundum, stones, description of, 13; illustration, 14; bench grinder, illustration, 14.
Care of paint brushes, 25.
Carriage bolts, 59; illustration, 57.
Carrier, for strawberries, 161–63; working drawing, 162; for raspberries and blackberries, 163; working drawing, 162.
Cattle husbandry, relating to, 204–11.
Cement and concrete, extent used, 2; school equipment for, 11; tools for, 20; kinds, 40, 41; special terms, 41; proportions, 41; strength of, 370.
Cementing compound, 46.
Chest, tool, 325–27; illustration, 326; working drawing, 327.
Chicks, mash hopper for, 98–101; working drawing, 99.
Chisels, description of, 13; illustration, 14; how to sharpen, 28.
Chute, for loading sheep, hogs, and cattle,

206–09; illustration, 206; working drawing, 207.
Clamp, hose, illustration, 62.
Clamp, saw, 32, 308, 309; working drawing, 308; height of, 33, 37.
Claw-hammer, illustration, 14.
Coach or lag screws, 59; illustration, 57.
Coal, for forge work, 47.
Cold chisel, illustration, 22.
Colony house, illustration, 134.
Combination flat and germination box, 64, 65; working drawing, 65.
Common rafters, lengths of, 283.
Compass saw, illustration, 18.
Composite shop, advantages of, 4, 6.
Compounds used in pipe fitting, 45, 46.
Concord clip, illustration, 363.
Concrete feeding floor, for hogs, 189–91; working drawing, 189; illustration, 190.
Concrete, forms for foundations, 274–77; illustration, 276; aggregate required, 42; made from one sack of cement, 282; sidewalk construction, 278–81; illustration, 279; accessories for work in, 268–72; working drawings, 269, 270.
Construction and repair work by Pennsylvania farmers, 2.
Conventional sections, 334–36; illustration, 236.
Convention lines, 333–35; illustration, 335.
Cooker, fireless, 292–95; illustration, 293; working drawing, 294.
Coöperation, 8.
Coop, one-hen brooder, 114–16; working drawing, 115; run-way for Fig. "A"; working drawing, 117, two-hen brooder, 116–20; working drawing, 119.
Coping saw, illustration, 18.
Corn, storage of seed, welded fencing, 146; illustration, 148; mouse-proof crate, 147–50; illustration, 148; working drawing, 149; rack, 150–52; illustration, 150; working drawing, 151.
Corrugated fasteners, 61; illustration, 62.
Countersink, rose, illustration, 15.
Coupling, illustration, 43.
Cow stanchion, 244, 245; working drawing, 243.
Crate, potato, 145, 146; illustration, 146; working drawing, 147; for shipping hogs, 187, 188; working drawing, 188.
Creep, for lambs and pigs, 215; working drawing, 214.
Cross, illustration, 43.
Cross-cut saw, one-man, illustration, 18; two-man, illustration, 18.
Cup hook, illustration, 62.

Dairy husbandry, relating to, 236–52.
Dibble, illustration, 66; working drawing, 70.
Door hasp, illustration, 62.
Doubletree, 253, 254; illustration, 254; working drawing, 255.
Drag sled, general purpose, 257, 258; working drawing, 257.
Draining pen, for sheep, 226, 227; illustration, 223; working drawing, 224.
Drawing, school equipment for, 11; table, 329–31; working drawing, 330.
Drawing-board support, 327–29; illustration, 328; working drawing, 329.
Drawing knife, its use, 13; illustration, 14.
Drawings, see Working Drawings.
Drawings, reading, 333–37.
Drier, or Japan, 51.
Drill, breast, illustration, 22; sizes for pipe connections, 45.
Drilling, for pipe connections, 45; tools used for, 13; illustration, 15.
Drive punches, illustration, 24.
Dry-mash hopper, indoor, for poultry, 101–03; working drawing, 99; illustration, 101, 102; out-door, 111–14; illustration, 111; working drawing, 112.

Educational considerations, 8.
Egg tester, with kerosene lamp, 93, 94; working drawing, 95; with electric light, 94; working drawing, 95.
Elbow, 45 degree, and 90 degree, illustration, 43.
Emery cloth, description and use, 55.
Equipment, for sowing and transplanting, illustration, 66; for school shops, 9–11; self-made, 297–331.
Estimating, paint, 52; wire fencing, 277; cement, mortar, and concrete, 282; common rafters, 283; lumber, sheathing, lap-siding, shingles, 39, 40.
Evener, three-horse, 254; working drawing, 255.
Experiment stations, and agricultural colleges, addresses of, 371–73.

Farm gates, 258–60; working drawing, 259.
Fasteners, nails, brads, screws, etc., 56–63.
Feed bin for poultry, 98; working drawing, 96.
Feed cart for silage, 247–49; working drawing, 248; illustration, 249.
Feeder, green feed for poultry, 107–09; illustration, 108; working drawing, 109.
Feeding floor for hogs, 189–91; working drawing, 189; illustration, 190.
Feed trough, for cattle, 205, 206; working drawing, 204; illustration, 205; for lambs, 213–15; illustration, 213; working drawing, 212; open types for poultry, 95, 97; working drawing, 96; portable, for sheep, 215–17; illustration, 213; working drawing, 216.
Fence post, concrete, 272–74; illustration, 225, 272–74; working drawing, 275; material required for, 277.
Fencing, wire, quantity required, 277.
Ferrule, brass, illustration, 62.
Field crops, projects relating to, 145–58.
File handle, 297–99; working drawing, 299; illustration, 301.
Files, kinds to use, 32; method of using, 33; variety needed, 13; illustration, 32; rack for, 301; illustration, 301; working drawing, 302.
Fillers, kinds, and use of, 54.

Finishing wax, kinds and use of, 54, 55.
Fireless cooker, 292–95; illustration, 293; working drawing, 294.
Fittings, pipe, illustration, 43.
Flat, combination, 64, 65; working drawing, 65.
Flatter, square, illustration, 22.
Flax thread, use of, 50.
Float, wood, long-handled, illustration, 20; short, 271; working drawing, 270.
Flower box, 288–92; working drawing, 290.
Fluxes and welding compounds, 48; for soldering, 48, 49; how applied, 48.
Forcing box, glass covered, 75, 76; working drawing, 76.
Forge practice, per cent of farmers who do, 2.
Forms for concrete foundations, 274–77; illustration, 276.
Foundation, concrete, forms for, 274–77; illustration, 276.
Frame, for cucurbits, 73–75; working drawing, 74.
Framing, rafters, 283–85; working drawing, 284; illustration, 282; square, illustration, 14, 282.
Fruit tree prop, 171, 172; working drawing, 171.
Fruit trees, distances for, 159.
Fruit, packing table for, 174, 175; illustration, 174; working drawing, 175.
Fuller, bottom and top, illustration, 22.

Gable-roof poultry house, 142, 143; illustration, 138; working drawing, 139.
Gang mould, for fence posts, 273, 274; illustration, 274; working drawing, 275.
Garden and lawn roller, 78–81; illustration, 79; working drawing, 81.
Gate, farm, 258–60; working drawing, 259.
General farm projects, 253–85.
General shop, 4.
Germination box, 64, 65; working drawing, 65.
Girders and beams, strength of, 369.
Glass cutter, illustration, 14.
Glider, illustration, 62.
Glue, kinds of, and characteristics, 56.
Grainsack or miller's knot, 348, 349; illustration, 349.
Grape arbors, 176–80; working drawing, 176, 178; illustration, 177, 179.
Green-house, illustration, 83.
Green-house bench, 81–84; working drawing, 82.
Grit and shell hopper, 110, 111; working drawing, 109; illustration, 110.
Guidance of thought and hand, 8.

Hack saw, illustration, 18.
Half hitch, 349; illustration, 350.
Halter tie, 348; illustration, 348.
Hame, bottom loop and clip, illustration, 363; staple, illustration, 363; how to remove staple, 364, 365; replacing staple, 365, 366; illustration, 366.
Hammer, claw, 15; illustration, 14; ball pene, illustration, 22; straight pene, illustration, 22; riveting, illustration, 24.
Handle for file, 297–99; working drawing, 299; illustration, 301.
Hand-mixing concrete, directions for, 42.
Hand saw-set, illustration, 18.
Hardie, illustration, 22.
Hardware, common articles of, 62.
Harness, care of, 50; 367, 368; oil, 50; thread, 50; leather, 50; clamp, 365–67; illustration, 367; hooks, 228–31; working drawing, 229, 230; needle, how to thread, 362; names of parts, 358; illustration, 358.
Harness repairing, tools used, 24, 357–60; illustration, 359; materials, 359, 360; illustration, 361.
Harness repair parts, 361; illustration, 363.
Hasp, steel hinge, door and stationary staple, illustration, 62.
Hay and grain rack, portable, for sheep, 220–22; illustration, 220, 226, working drawing, 221; stationary, for sheep, 223–25; working drawing, 222.
Hayrack and manger, for loose cattle, 209; working drawing, 208.
Hinge hasp, illustration, 62.
Hinges, 61; illustration, 62.
Hod for wrapping paper, 172; working drawing, 171.
Hog house, the Iowa gable-roof, 193–97; illustration, 196; working drawing, 194, 195; portable, "A"-shaped, 191–93; working drawing, 192; illustration, 193.
Hog hurdle, 184–86; working drawing, 185.
Hog pen, knock-down, 187; working drawing, 186.
Hog trough and chute, 181–83; working drawing, 182; trough of concrete, 183, 184; working drawing, 184.
Home, projects relating to the farm, 286–96.
Hook, and eye, cup, shoulder, screw, illustration, 62.
Hooks, for harness, 228–31; working drawing, 229, 230.
Hopper, for grit and shell, 110, 111; working drawing, 109; illustration, 110; out-door dry-mash, 111–14; illustration, 111, 113; working drawing, 112.
Horse husbandry, relating to, 228–35.
Horse, saw, 312–14; illustration, 312; working drawing, 313; shoeing, per cent of farmers who do, 2.
Horticulture, projects relating to, 159–80.
Hose clamp, illustration, 62.
Hotbed, wood pit type, 85, 86; working drawing, 84; portable knock-down surface type, 86, 87; illustration, 86, 87; permanent, concrete type, 88–90; working drawing, 89.
Hurdle for hogs, 184–86; working drawing, 185.
Hutch, rabbit, portable, 266–68; working drawing, 267.

Illustrations (from photographs, etc. *References are to pages*) — arbor, grape, 177, 179; automobile truck, 264; barrel hitch,

351; belt and harness repair tools, 359, 360; belts, correct way to run, 353; belt lacing, 355; blackwall hitch, 350; bowline knot, 347; combination farm shop and garage, facing page 1; conventional lines, 335; sections, 336; doubletree, 254; drawing-board support, 328; dry-mash hopper, 101, 102; farm blacksmithing, 8, 12; farm shop and garage, interior, 2; farm shop building, in California, 5; exterior, 3; in Missouri, 5; side view, 3; feeding floor, 190; feed rack, for sheep, portable, 226; Western type, 225; feed trough, for cattle, 205; portable for sheep, 213; fence posts, 225, 272, 273; files, cuts used on, 34; file rack, 301; fireless cooker, 293; forms for concrete foundations, 276; greenhouse, 83; half hitch, 350; halter tie, 348; hame staple, removing and replacing, 364–66; hardware, common articles of, 62; harness repair parts, 363; harness, single buggy, 358; team, 358; harness thread, 361; hay and grain rack, portable, for sheep, 220; hog house, Fig. "A"-type, 193; Iowa type, 196; hopper, for green feed, 108; for grit, 110; portable, out-door, 111, 113; hotbed, four-sash size, 86; two-sash size, 87; knots, elements of, 345; lettering, 332, 334; loading chute for hogs, sheep, and cattle, 206; lumber rack, 315; machine shed, 280; mallet, 311; marker and vegetable flat, 68; milk cooling vat, 251; milk record case, 245; miller's knot, 349; mould for fence posts, 274; nails, brads, and screws, 57; oilstone, base for, 297; orchard ladder, 167; overhand knot, 345; packing table, 174; pipe fittings, 43; plank drag, 152; planting board, 160; plants ready for the garden, 72; potato crate, 146; potato cutting crate, 156; potting benches, 77; poultry house, Connecticut, 132; Illinois, 141; Indiana, 133; Kansas, 135; Missouri, 138; Washington, 136; Wisconsin, 134, 140; projection, 337; projects made at Towanda, Pa., 331; rack for drills and bits, 300; roller, 79; runner cutter, 163; rope halter, 350; rope, how to whip end of, 343, 344, 345; saw buck, 288; saw filing clamp, 307; saw horse, 312; seed corn, curing frame, 150; rack and crate, 148; self-feeder for hogs, 199, 201; Iowa type, 202; Kansas type, 181; Ohio type, 197; sheep dipping demonstration, 223; sheepshank, 350; sheep shearing, 219; shelf or book rack, 286; sidewalk construction, 279; silage or feed cart, 249; slip knot, 347; smoke house, 202; soil crops rack, 154; soil sieves, 72; splicing rope, 349; spotting board, 69; plants set in holes made with, 71; stanchions for calves, 241; stanchions, swinging, 239; stepladder, orchard type, 165; stitching horse, 362; square knot, 346; timber hitch, 350; tool and nail box, 310; tool chest, 326; tool cabinet, interior, 7; showing tools, 7; tools, blacksmithing, 22, 23; boring, drilling, and reaming, 15; cement working, 20; files, 32; jointing, setting, and filing, 36; leather working, 24; pipe fitting, 21; planes, 16; saw jointers, 30; saws and saw-sets, 18; woodworking, 14. utility box, 304; vegetable gardening equipment, 66; wagon box, 262; wall nest, 123; water tank, 251; water stand for poultry, 103; weaver's knot, 346; work bench, plugging top, 320; showing vise and drawer construction, 318; wool tying box, 217.

Incubation and brooder coop, two-hen, 116–20; working drawing, 119.

Initiative, 8.

Instruction, purpose of, 8.

Iowa gable-roof hog house, 193–97; illustration, 196; working drawing, 194, 195.

Iron, wrought, Norway, and cast, 47.

Jack plane, 17; illustration, 16.

Jig, for making apple boxes, 172, 173, working drawing, 173.

Jointer, saw, 305–08; illustration, 30, 36; working drawing, 306.

Knots, hitches, and splices, blackwall hitch, 349; illustration, 350; bowline, 347, 348; illustration, 347; grainsack or miller's, 348, 349; illustration, 349; halter tie, 348; illustration, 348; overhand, 345; illustration, 345; sheepshank, 350, 351; illustration, 350; slip, 347; illustration, 347; square, 345; illustration, 345; timber, 349; illustration, 350; weaver's, 346, 347; illustration, 346; characteristics, and terms used, 345.

Lacing belts, methods of, 354–57; illustration, 355; table of data concerning, 357.

Ladder, orchard type, 165–68; illustration, 167; working drawing, 168.

Lay-out, for drawings, 339; illustrations, 338–40.

Leather work, nature of, 3; school equipment for, 11; riveting, 364.

Lettering, 332, 334.

Level, need for, 16.

Lever butter worker, 249–252; working drawing, 250.

Link, patent, open; illustration, 62.

Linseed oil, 51.

Liquid fillers, use of, 54.

Liquid glue, characteristics, 56.

List of tools for work in: wood, cement, and concrete, 20; pipe fitting, 21; blacksmithing, 23; soldering and babbitting, 24; harness and leather, 24; painting, 25.

Lock washer, illustration, 62.

Loop, description of, 345.

Lubrication, on twist drills, 28.

Lumber, rack, 314–16; working drawing, 314; illustration, 315; units of measurement, 39; common sizes, 39; estimating, 39, 40.

Machine bolts, 59; illustration, 57.

Machine screws, sizes of, 60.

Mallet, 311, 312; illustration, 311; working drawing, 311.
Manger, and hay rack for loose cattle, 209; working drawing, 208; and stall for horses, 232–35; working drawing, 233; and stall for steers, 210, 211; working drawing, 210.
Marker, for vegetable flats, 68, 69; illustration, 66; working drawing, 67.
Mash hopper for chicks, 98–100; working drawing, 99; indoor, for poultry, 101–03; working drawing, 99; illustration, 101, 102.
Materials, blacksmithing, 46; soldering and babbitting, 48, 49; harness and leather, 50; reducing cost of, 4; nature of, 4; quantities required for, mortar and concrete, 42; pipe fitting, 42, 43.
Measuring box, 268; working drawing, 269.
Mechanical drawing and sketching, 332–41.
Metal-work, school equipment for, 10, 11.
Method, governing considerations, 8.
Milk cooling vat, 252; illustration, 251.
Milk record case, 245–47; illustration, 245; working drawing, 246.
Milking stools, 237–40; working drawing, 238.
Miter box, 302–04; working drawing, 303.
Mixing box, 268; working drawing, 269.
Mixing platform, 269–71; working drawing, 269.
Mixing shovel, cementer's, illustration, 20.
Mixture, definition of, for cement work, 41.
Models, construction of, 6.
Monkey wrench, illustration, 21.
Mortar, quantities required for, 42.
Mould, for concrete fence posts, 273, 274; illustration, 274; working drawing, 275.

Nails, wire, 56; steel cut, 57; brads and screws, illustration, 57; length, thickness, and weight, 58.
Nail sets, kinds of, 16.
Natural cement, 41.
Nature of construction and repair work, done by successful farmers, 2.
Neckyoke, 253; working drawing, 255.
Nest of saws, illustration, 18.
Nests, double-tier wall type, 122–25; illustration, 123; working drawing, 124; under dropping boards, 125–27; working drawing, 126; single-tier wall type, 127, 128; working drawing, 128; trap, 129–31; working drawing, 130.
Nipple, long, and short, illustration, 43.
Norway iron, description of, 47.
Nut coupling, illustration, 43.
Nut, wing, illustration, 62.

Oats sprouter, for poultry, 105, 106; working drawing, 107.
Ohio self-feeder for hogs, 198–201; illustration, 197; working drawing, 198.
Oil, linseed, 51; stains, characteristics and use of, 53; for pipe fitting, 46.
Oilstone, base for, 297; illustration, 297; working drawing, 298; description of, 13; illustration, 14.
Oily waste, care of, 26.
Orchard ladders, rigid type, 165; illustration, 165; working drawing, 166; movable leg, 169, 170; working drawing, 170.
Overhand knot, 345; illustration, 345.

Packing table, for fruit, 174, 175; illustration, 174; working drawing, 175.
Paddle, butter, 237; working drawing, 236.
Padlock eye, illustration, 62.
Paint brushes, description of, and care, 25.
Paint, composition of, 50, 51; ready mixed, 51; estimating the amount required, 52; varnishes and stains, 50–55.
Paper hod, for wrapping fruit, 172; working drawing, 171.
Paste fillers, use of, 54.
Pen, for draining dipped sheep, 226, 227; illustration, 223; working drawing, 224; knock-down, for hogs, 187; working drawing, 186.
Piano-box poultry house, 143, 144; illustration, 140.
Pipe, cap, illustration, 43; compound, 45, 46; cutter, illustration, 21; fitting equipment for schools, 11; materials used, 42; standard fittings, illustration, 43; kinds of, 42, 43; lengths, 44; standard dimensions, 44; lengths of thread, 45; stock and dies, illustration, 21; vise, illustration, 21.
Pitch, and degrees on the steel square, 282–84; illustration, 282; working drawing, 284.
Plane blades, how to sharpen, 29.
Planes, types of, 16; sizes, 17; illustration, 16.
Plank drag, 152–54; illustration, 152; working drawing, 153.
Planting boards, 159–62; illustration, 160; working drawing, 161.
Plates, standard sizes for drawing, 339; illustration, 338–40.
Platform, mixing, 269–71; working drawing, 269.
Pliers, illustration, 14.
Plow, snow, 264–66; working drawing, 265.
Plug, illustration, 43.
Points, saw, per inch, 31.
Portable run-way for chicks, 121, 122; working drawing, 121.
Portland cement, 41.
Post, concrete fence, 272–74; illustration, 225, 272–74; working drawing, 275; material required for, 277.
Posts, gas-pipe, bearing power of, 369; wood, bearing power of, 369.
Potato, seed, tray, 145; working drawing, 147; crate, 145, 146; illustration, 146; working drawing, 147; seed cutting rack, 156–58; illustration, 156; working drawing, 157.
Potting bench, 77, 78; illustration, 77; working drawing, 78.
Poultry house, requirements, 131–35; illustration, 132, 133, 134; types, 134, 135; illustration, 133, 134; working drawing, 137, 139; size and foundations, 135; walls,

openings, 136, 137; roof, fixtures, 138, 139; broody coop, feed hoppers, drinking fountains, nests, curtains, and doors, 140, 142.
Poultry husbandry, relating to, 93–144.
Problem solving attitude, 8.
Projection, orthographic, and isometric, 335–38.
Projects, cost control of, 4; size of, 6, 9.
Prop, for fruit trees, 171, 172; working drawing, 171.
Proportions, for mixing concrete, 41.
Publishers, addresses of, 371.
Pulley, illustration, 62; speeds, how to calculate, 354.
Punches, drive, illustration, 24.
Purpose of farm shop instruction, 1
Purposing, individual, 8.
Push drill, illustration, 14.
Putty, how made, how removed, substitute for, 52; knife, substitute for, 25.

Rabbit hutch, portable, 266–68; working drawing, 267.
Rack, for files, 301; illustration, 301; working drawing, 302; hay and grain, portable, for sheep, 220–22; illustration, 220, 226; working drawing, 221; stationary, for sheep, 223–25; working drawing, 222; for lumber, 314–16; working drawing, 314; illustration, 315.
Rafters, how to cut, 283–85; illustration, 282; working drawing 284; lengths of common, 283.
Raker gauge, illustration, 36.
Ratchet screwdriver, illustration, 14.
Reamer, burring, illustration, 21; square, illustration, 15.
Reaming, tools used for, 15; illustration, 15.
Record case, milk, 245–47; illustration, 245; working drawing, 246.
Repair link, open, illustration, 363; lap, illustration, 363.
Rivet set and header, illustration, 24.
Riveting hammer, illustration, 24.
Rivets, copper, tinner's, and iron, 60, 61; illustration, 57.
Roller, garden and lawn, 78–81; illustration, 79; working drawing, 81.
Roof, framing, 283–85; illustration, 282; working drawing, 284; types, illustration, 281.
Rope, how to whip end of, 344, 345; illustration, 343–45; its care, 343; kinds, standard size, weight, and strength, 342, 370; on the farm, 342–52.
Rope work, extent to be taught, 3.
Rule for finding board feet in lumber, 40.
Runner cutter for strawberries, 163, 164; illustration, 163; working drawing, 164.
Run-way for Fig. "A" coop, 116; working drawing, 117; for chicks, 121, 122; working drawing, 121.

Salable product, 4.
Sand-paper, description and use, 55.
Sawbuck, 288; illustration, 288; working drawing, 289.
Saw clamp, 308, 309; working drawing, 308; illustration, 18.
Sawhorse, 312–14; illustration, 312; working drawing, 313.
Saw-jointers, types of, 305, 308; illustration, 30; working drawing, 306.
Saws, hand, setting, 29–31; filing, 32, 33; filing for cross-cutting, 33–35; buck, pruning, and compass, 35; rip, 36, 37; and saw-sets, 18, 19; one- and two-man cross-cut, how to joint, set and file, 37, 38.
School shop, purpose of, 1; kinds of work for, 1; illustration, 3, 5; economical type of, 4.
Scraper, from saw blade, 26.
Screen, for sand or gravel, 271, 272; working drawing, 270; window, 296; working drawing, 295.
Screened frame for cucurbits, 73–75; working drawing, 74.
Screw, cockeye, illustration, 363; dee, illustration, 363; eyes, illustration, 62; plate, illustration, 21; driver, illustration, 14; driver bits, how to sharpen, 28.
Screws, illustration, 57; sizes of wood and machine, 60.
Seat, wagon, 260–62; working drawing, 261.
Seed potato, tray, 145; working drawing, 147; cutting rack, 156–58; illustration, 156; working drawing, 157.
Seed corn storage, welded fencing, 146; illustration, 148; mouse-proof crate, 147–50; illustration, 148; working drawing, 149; rack, 150–52; illustration, 150; working drawing, 151.
Self-feeder for hogs, Kansas type, illustration, 181; by U.S. Dept. of Agriculture, 201–03; working drawing, 200; illustration, 199; Ohio type, 198–201; illustration, 197; working drawing, 198.
Set gauge, illustration, 36.
Setting block, illustration, 36.
Sharpening tools, general principles, 27; auger bits, 27; twist drills, 28; screwdriver bits, 28; chisels, 28; plane blades, 29; shears, 29; hand saws, 29–37; shears, 29.
Shed-roof poultry house, 142; illustration, 133, 134, 136; working drawing, 137.
Sheep husbandry, projects relating to, 213–27.
Sheepshank, 350, 351; illustration, 350.
Sheet iron and steel, gauge and weight, 49.
Sheet-metal work, extent to be taught, 4; equipment for, 11.
Shelf block, illustration, 62.
Shelf, standing, 286, 287; illustration, 286; working drawing, 287.
Shellac, description and use of, 53.
Shipping crate for hogs, 187, 188; working drawing, 188.
Shop, equipment for schools, 9–11; lay-out and arrangement, 6; type of, 4.
Shoulder hooks, illustration, 62.
Side boards, and wagon box, 262–64; illustration, 262; working drawing, 263.
Side-dressing, saws, 35.
Sidewalk, concrete, 278–81; illustration, 279.

Sieve, soil or manure, 72, 73; illustration, 66, 72.
Silage or feed cart, 247–49; working drawing, 248; illustration, 249.
Singletree, 253; illustration, 254; working drawing, 255.
Sizes of wood and machine screws, 60.
Sketching and mechanical drawing, 332–41.
Sled, drag, 257, 258; working drawing, 257.
Sledge, illustration, 22.
Slip knot, 347; illustration, 347.
Smoke house, 203; illustration, 202.
Smooth plane, 17; illustration, 16.
Snap, harness, illustration, 62, 363.
Snips, illustration, 24.
Snow plow, 264–66; working drawing, 265.
Socket firmer chisel, illustration, 14.
Soil, bearing power of, 369.
Soil crops rack, 154–56; illustration, 154; working drawing, 155.
Solder, description of, 48.
Soldering and babbitting, school equipment for, 11.
Soldering set, illustration, 24.
Spirit stains, characteristics and use, 53.
Spoke shave, illustration, 14.
Spotting board, 69, 70; illustration, 66; working drawing, 70; plants set in holes made by, illustration, 71; plants ready for the garden, 72.
Sprouter, oats, 105–06; working drawing, 107.
Square, the steel, illustration, 14, 282; description, 19; working drawing, 284.
Square knot, illustration, 346.
Square reamer, illustration, 15.
Stains, purpose, kinds, characteristics, 53, 54.
Stakes for tomatoes, 90; working drawing, 91.
Stall and manger, for horses, 232–35; working drawing, 233; for steers, 210, 211; working drawing, 210.
Stanchion, swinging, 240–42; working drawing, 240; illustration, 239; calf, 243, 244; working drawing, 243; illustration, 241; cow, 244, 245; working drawing, 243.
Standards of workmanship, 7.
Standard dimensions for steam, gas, and water pipe, 44.
Standing part, definition of, 345.
Staples, sizes of, 61; illustration, 62.
Steel, mild, and tool, description of, 47; strength of, 370.
Stepladder, rigid orchard type, 165; illustration, 165; working drawing, 166; orchard type, 169, 170; working drawing, 170.
Stillson wrench, illustration, 21.
Stitching horse, illustration, 362.
Stitching leather, 362, 363.
Stock and dies, pipe, illustration, 21.
Stock-loading chute, 206–09; illustration, 206; working drawing, 207.
Stools, milking, 237–40; working drawing, 238.
Stove bolts, illustration, 57.
Straight pene hammer, illustration, 22.
Strap, illustration, 43.
Strap hinge, 62.
Strength of materials, 342, 369, 370.
Subject-matter, governing considerations, 8.
Support for drawing-board, 327–29; illustration, 328; working drawing, 329.
Swage, bottom and top, illustration, 22.
Swaging hammer and anvil, illustration, 36.
Swine husbandry, projects relating to, 181–203.
Swinging stanchion, 240–42; working drawing, 240; illustration, 239.

Table, for drawing, 329–31; working drawing, 330; for packing fruit, 174, 175; illustration, 174; working drawing, 175.
Tables — beans and girders, 369; belt lacing, 357; board measure, 40; equipment for school shop, 9–11; feeding floors, area of, 191; fence posts, material required for concrete, 277; files to use, 32; fruit trees, distances for, 159; mortar and concrete, materials required, 42; quantities made from 1 sack of cement, 282; nails and brads, 58; pipe connections, drills used, 45; pipe, standard dimensions, 44; length of threads, 45; planes, sizes of, 17; posts, pipe, strength of, 369; wood, strength of, 369; rafters, length of, 283; rope, data concerning, 342; screws, lengths and gauges, 61; screws, wood and machine, 60; sheet iron and steel, 49; wire fencing, quantities required, 277.
Tacks, illustration, 57.
Tamper, cementer's, illustration, 20; for concrete, 271; working drawing, 270; for vegetable flats, 67, 68; illustration, 66; working drawing, 67.
Taps, illustration, 21; and dies, extent used, 2.
Tap wrench, illustration, 21.
Tee, illustration, 43; bevel, illustration, 14; hinge, illustration, 62.
Tempering, per cent of farmers who do, 2.
Threads, right and left hand, 45; lengths, 45.
Timber hitch, 349; illustration, 350.
Tinner's rivets, 61; illustration, 60.
Tin plate, sizes of, 49.
Tomatoes, stakes for, 90; working drawing, 91; trellis, 90–92; working drawing, 91.
Tongs, types of, illustration, 23.
Tool and nail box, 309, 310; illustration, 310; working drawing, 310.
Tool box, 324, 325; working drawing, 324.
Tool chest, 325–27; illustration, 326; working drawing, 327.
Tools, description of, 12–16; illustrations, 14–16, 18, 20–24; list of, for wood, 19; for cement and concrete, 20; for pipe fitting, 21; for blacksmithing, 23; for soldering and babbitting, 24; for harness and leather, 24; for painting, 25; for saw filing, 32, 36, 37.
Trap nests, 129–31; working drawing, 130.
Trough, and chute for hogs, 181–83; working drawing, 182; of concrete, 183, 184; working drawing, 184; for cattle, 205, 206; working drawing, 204; illustration, 205; for lambs, 213–15; illustration, 213; working

drawing, 212; for sheep, 215–17; illustration, 213; working drawing, 216; water, 231, 232; working drawing, 231.
Trowel, pointing, illustration, 20; cementer's, illustration, 20.
Truck made from automobile, illustration, 264.
Tug hook, illustration, 363.
Turpentine, 51.
Twist drills, how to sharpen, 28.
Tying box, for wool, 217–20; illustration, 217; working drawing, 218.
Type of shop, 4.

Utility box, 304, 305; illustration, 304; working drawing, 305.

Values, immediate versus deferred, 9.
Varnish, description and use of, 52.
Vegetable flat, 66; illustration, 66; working drawing, 70.
Vegetable gardening, relating to, 64–92.
Ventilation, of poultry houses, 132–34.
Vise, oval slide blacksmith's, and machinists, illustration, 22; pipe, illustration, 21.

Wagon box with side boards, 262–64; illustration, 262; working drawing, 263.
Wagon jack, 254–57; working drawing, 256.
Wagon seat, 260–62; working drawing, 261.
Wash bench, 292; working drawing, 291.
Washer, lock, illustration, 62.
Water pipe, nominal, and actual dimensions, 44.
Water stains, characteristics and use of, 54.
Water stand, for poultry, 103–05; illustration, 103; working drawing, 104.
Water tank, 252; illustration, 251.
Water trough, 231, 232; working drawing, 231.
Wax, finishing, use of, 54.
Weaver's knot, 346, 347; illustration, 346.
Welding, compounds, 48; per cent of farmers who do, 2.
White lead, 51.
Window screens, 296; working drawing, 295.
Wing nut, 62.
Wire fencing, quantities required for fields of certain sizes, 277.
Wire screw hooks, illustration, 62.
Wood float, for concrete work, 271; working drawing, 270.
Wood screws, styles of, 58, 59; illustration, 57; sizes, 60.
Woodwork, school equipment for, 9, 10.
Wool tying box, 217–20; illustration, 217; working drawing, 218.
Work bench, 316–23; working drawing, 317, 319, 322, 323; illustration, 318, 320.
Working drawings (*references are to pages*) —arbor, grape, 176, 178; bench, greenhouse, 82; bench vise, 319; belt lacing, 355, 356; berry carriers, 162; brooder coop, one-hen, 115; butter paddle, 236; butter worker, 250; creep for lambs and pigs, 214; doubletree, 255; drag sled, 257; draining pen, 224; drawings, sizes of, 338; drawing-board support, 329; drawing table, 330; dry-mash hopper, 99; egg testers, 95; evener, 255; feeding floor, 189; feed trough, for cattle, 204; for lambs, 212; for poultry, 96; for sheep, 216; fence posts, 275; file handles, 299; file rack, 302; fireless cooker, 294; flat, and germination box, 65; float, 270; flower boxes, 290; forcing box, 76; frame for cucurbits, 74; framing rafters, 284; gates, 259; harness clamp, 367, harness hook, 229, 230; hay and grain rack, portable, for sheep, 221; stationary, for sheep, 222; hod for wrapping paper, 171; hog house, Iowa type, 194, 195; portable, 192; hog hurdle, 185; hog pen, knock-down, 186; hog trough, 184; hog trough and chute, 182; hopper, for grit and shell, 109; outdoor, dry-mash, 112; hotbed, concrete, 89; pit type, 84; incubation and brooder coop, 119; jig for making apple boxes, 173; lumber rack, 314; mallet, 311; manger and stall for horses, 233; for loose cattle, 208; for steers, 210; measuring box, 269; milking stools, 238; milk record case, 246; miter box, 303; mixing box, 269; mixing platform, 269; neckyoke, 255; nests, single tier, 126; single-tier wall type, 128; oats sprouter, 107; oilstone, base for, 298; orchard ladder, 168, 170; packing table, 175; plank drag, 153; planting boards, 161; potato cutting crate, 157; potato crate, 147; potting bench, 78; poultry house, 139; shed roof type, 137; prop for fruit trees, 171; rabbit hutch, 267; rack for drills and bits, 300; roof types, 281; roller, 81; runner cutter, 164; run-way, for chicks, 121; for Fig. "A" coop, 117; sawbuck, 289; saw filing clamp, 308; sawhorse, 313; saw-jointer, 306; screen, for sand and gravel, 270; seed corn crate, 149; seed corn rack, 151; self-feeder for hogs, 200; Ohio type, 198; shelf or book rack, 287; shipping crate for hogs, 188; silage or feed cart, 248; singletree, 255; snow plow, 265; soil crops rack, 155; stanchions, for calves, 242; for cows, 343; swinging, 240; steel square, 282; stepladder, orchard type, 166; stock loading chute, 207; supports for tomatoes, 91; tamper, 270; tamper, marker, and vegetable flat, 67; tool box, 324; tool chest, 327; tool and nail box, 310; trap nests, 130; utility box, 305; wagon box with side boards, 263; wagon jack, 256; wagon seat, 261; wall nest, double-tier, 124; wash bench, 291; water stand for poultry, 104; water trough, 231; window screen, 295; wool tying box, 218; work bench, 317; work bench drawer, 322; work bench stop, 323.
Wrenches, monkey, Stillson, and tap, illustration, 21.

BOSTON PUBLIC LIBRARY
3 9999 08726 383 4

THE REAL DIARY OF THE WORST FARMER

By

Judge Henry A. Shute

Author of "The Youth Plupy," "The Real Diary of a Real Boy," "Farming It," etc.

"The Real Diary of the Worst Farmer" is a consummate bit of barnyard fun. The acquisition of poultry and domestic animals by a business man with rural longings, his bland confidence in being able to carry on work with the soil because it is so "natural," his naïve approach to farming problems — these are the themes which develop, under Judge Shute's ebullient pen, numberless ramifications of humor. A recalcitrant cow, a rufescent tempered rooster, a too-masterful mare, — these are the difficult personalities with which a man of law, turned farmer, has to reckon.

This book will easily take its place by the side of "The Real Diary of a Real Boy," and it is something of a sequel to that inimitable volume, "Farming It." Judge Shute's humor is the kind that appeals to everybody, and not even the most chronically serious person can resist the fun of this new book.

BOOKS OF TRAVEL, OUTDOORS, & ADVENTURE

OLD INDIAN TRAILS — *Walter McClintock*

An absorbing outdoor book by an adopted member of the Blackfoot tribe of Indians, as well as a unique contribution to Indian lore. *Lavishly illustrated.*

SATCHEL GUIDE TO EUROPE

W. J. Rolfe. Revised by William Day Crockett

Revised abroad last summer by Professor Crockett, this new edition of the pocket guide to Europe is of invaluable aid to the transatlantic traveler.

THE UNVEILED LADIES OF STAMBOUL — *Demetra Vaka*

A vivid picture of the "new women" of Turkey, who, with lifted veils, love, hate, and intrigue even more ardently than they did behind barred windows and palace guards. *Illustrated.*

THE SOUTHERN SIERRAS OF CALIFORNIA

Charles Francis Saunders

A delightful travel book, describing one of the most beautiful wonder regions of America. *Illustrated.*

WANDERINGS IN THE QUEENSLAND BUSH

W. Lavallin Puxley

An enthralling record of existence in the "dead heart of Australia," which will please naturalist and lay reader alike. *Lavishly illustrated.*

CLIMBS ON ALPINE PEAKS

Abate Achille Ratti, Mountaineer (Now Pope Pius XI)

Both the interest of the subject and the eminence of the author give to this little book an unusual and world-wide interest. *Illustrated.*

TERRY'S GUIDE TO MEXICO. New and revised edition, pocket size. — *T. Philip Terry, F.R.G.S.*

The new standard guidebook to Mexico, with chapters on Cuba, the Bahamas, and the ocean routes to Mexico. With 2 maps and 28 plans.

ROADS OF ADVENTURE — *Ralph D. Paine*

A stirring autobiographical narrative of adventure as a filibuster in Cuba, as a war correspondent, and in other fields. *Illustrated.*

INCA LAND — *Hiram Bingham*

An absorbing account of explorations in the highlands of Peru, and of the discovery of the wonderful Inca city of Machu Picchu. *Profusely illustrated.*

A NATURAL HISTORY OF THE DUCKS, Vol. I

John Charles Phillips

A monumental work written by a well-known authority and beautifully illustrated (principally in color) by Louis Agassiz Fuertes and Allan Brooks, with a frontispiece by Frank W. Benson. To be complete in four volumes.